APR 30 1930

Engineering Library

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VOL. CXLIX.—No. 3875] LONDON: FRIDAY EVENING, APRIL 18, 1930 [PRICE ONE SHILLING SUBSCRIPTION POST 1s. 3d.

PUBLIC NOTICES

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/1973.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of TRINIDAD, for the Public Works Department, for three years' service with possible extension, at a salary of £500, rising to £600 a year by annual increments of £25. Free passages. Candidates, 25 to 30 years of age, preferably unmarried, must have passed Sections A and B of the Examination for the A.M. Inst. C.E. Diploma, or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations, and have had at least three years' practical experience upon Engineering Works of some magnitude, especially in the Construction and Maintenance of Roads and Bridges. Candidates up to 35 years of age will be considered, but they must have had at least five years' practical experience.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/1973. 4861

The Government of Bengal invite APPLICATIONS for the POST of PROFESSOR OF MECHANICAL ENGINEERING, Bengal Engineering College, Sibpur, Bengal. Candidates must be not less than 30 nor more than 40 years of age. They must hold a good Degree in Mechanical Science Tripos, Cambridge, or in Mechanical Engineering from Glasgow, London, Manchester, Birmingham or Dublin University, have had adequate experience in Mechanical Engineering Workshops of firm of repute, and be Associate Members of the Institution of Mechanical Engineers. Preference will be given to candidates who have had some university teaching experience.

Salary Rs. 700 a month, rising by annual increments of Rs. 50 a month to Rs. 900. In addition, overseas pay of £25 a month will be granted to an officer of non-Asiatic domicile. (Sterling equivalent per annum at current rate of exchange Rs. 700 plus £25, £930 ; Rs. 900 plus £25, £1110.) Appointment on agreement for five years in first instance, with possibility of extension. Free first-class passage to India. Provident Fund. Free unfurnished quarters, subject to payment of municipal taxes. Strict medical examination.

Selected candidate will be required to join the appointment by the third of November, 1930.

Further particulars and forms of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, India House, Aldwych, London, W.C. 2. Last date for receipt of applications 19th May, 1930. 4843

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that SIR ALFRED HERBERT, of Dunley Manor, near Whitchurch, Hampshire, and JOHN MILBURN, of Canley Corner, Kenilworth-road, Coventry, Warwickshire, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 323,461, granted to them for an invention entitled "Chucks."

Particulars of the proposed Amendment were set forth in No. 2151 of the "Illustrated Official Journal (Patents)" published on the 9th April, 1930.

Any person or persons may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of publication of the said Journal.

W. S. JARRATT,
Comptroller-General.
P4016

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

APPLICATIONS are INVITED for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advance study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms (T3) 300 may be obtained from the EDUCATION OFFICER (T. 3), The County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1930.

MONTAGU H. COX,
Clerk of the London County Council.
4836

Crystal Palace School of Practical ENGINEERING.
Principal : MAURICE WILSON, M. Inst. C.E.

SPECIAL NOTICE.

This School is now full. Intending Students are requested to enter their names without delay for the Winter Term to avoid disappointment.

SUMMER TERM BEGINS on APRIL 30th.
4837

Leicester City Education COMMITTEE.
LEICESTER COLLEGE OF TECHNOLOGY.
(L. W. KERSHAW, B.Sc., A.M. Inst. C.E., Principal.)

WANTED, for 1st September, 1930, a FULL-TIME GRADUATE ASSISTANT in the Department of Engineering.

In addition to being in possession of the necessary academic qualifications, applicants must be experienced practical Mechanical Engineers.

Salary according to the Burnham Scale.

Applications, together with copies of testimonials, should be sent to the Registrar, at the College, not later than May 18th, 1930.

F. P. ARMITAGE,
Director of Education.
4849

The Engineer

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PUBLIC NOTICES

Borough of Gosport.
REPAIRS TO LANDING STAGE, &c.

The Gosport Corporation are prepared to receive TENDERS for REPAIRING the FLOATING LANDING STAGE and the BROW connecting it with the shore and other contingent works.

The contract drawings and specification may be seen at the offices of the Engineers, Sir John Wolfe Barry and Partners, Dartmouth House, 2, Queen Anne's-gate, Westminster, S.W.1, on and after Wednesday, the 23rd April, between the hours of Eleven and Four, and copies of the drawings and specification, together with a schedule of quantities and form of Tender, may be obtained there upon payment of Five Guineas. This sum will be repaid by the Corporation upon receipt of a bona fide Tender, accompanied by the specification and drawings, which are to be returned with the Tender.

Tenders, endorsed "Tender for Repairs to Landing Stage, &c.," must be delivered under seal at the office of the Town Clerk, Gosport, Hants, on or before Noon on Saturday, 17th May.

The lowest Tender will not necessarily be accepted.

H. R. MANGNALL,
Town Clerk.
Town Hall, Gosport,
15th April, 1930. 4856

Cornwall County Council.
TORPOINT FERRY.

TENDERS are INVITED for the CONSTRUCTION of LANDING BEACHES and RE-FORMING EXISTING BEACHES, including FORMATION of DAMS, STEEL SHEET PILING, TIMBER PILING, CONCRETE REVETMENTS and SURFACE WORKS, at Torpoint, Cornwall, and Devonport, Plymouth, in accordance with plans and specification prepared by Mr. H. Victor Prigg, Chartered Civil Engineer, Plymouth.

Plans and specification may be seen at the office of the Ferry Manager, Torpoint, Cornwall, or at the Engineer's Office, South Devon Chambers Millbay Station, Plymouth, on and after Tuesday, the 8th April, 1930.

A form of Tender and bill of quantities may be obtained from the Engineer on payment of Two Guineas which will be returned upon receipt of a bona fide Tender.

The lowest or any Tender will not necessarily be accepted.

Tenders must be delivered to the undersigned not later than the 22rd April, 1930.

T. A. H. SHEERS,
Deputy Clerk of the County Council.
County Hall, Truro,
4th April, 1930. 4798

PUBLIC NOTICES

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for—

(1) 13 BOILERS for H.M. Class Engines.
(2) 12 BOILERS for F. Class Engines.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Wednesday, 16th April, 1930.

A fee of 20s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Friday, 2nd May, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. GRANT,
Secretary.
4859

County Borough of Halifax.
HALIFAX CORPORATION WATERWORKS.
WARLEY MOOR RESERVOIR.

The Waterworks Committee are prepared to receive TENDERS for the RECONDITIONING of WARLEY MOOR or "FLY FLAT" RESERVOIR, situate at the head of Luddenden Brook, about ¾ miles from Halifax. The work will consist of the Construction of an Embankment across the Northern End of the Reservoir, the Removal of Peat from the Bottom of the Reservoir, and its Disposal behind the said Embankment ; the Lining of an existing Catchwater ; and the Construction of an Entrance Road, &c.

Drawings may be seen and copies of the specification, schedule and form of Tender obtained on application to Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon the receipt of a cheque for Five Guineas. This sum will, after the Corporation shall have come to a decision upon the Tenders, be returned to those parties who shall have sent in a bona fide Tender, shall not have withdrawn the same, and shall have returned the documents and drawings lent to them for the purpose of making up their Tender. A limited number of sets of drawings (uncoloured) are available and will be lent to persons tendering in priority of application on receipt of the sum of Two Guineas, which will not be returned.

Sealed Tenders, endorsed "Halifax Corporation Waterworks, Warley Moor Reservoir," must be forwarded to the Town Clerk, Town Hall, Halifax, on or before Friday, the 16th May, 1930.

The Committee do not bind themselves to accept the lowest or any Tender.

PERCY SAUNDERS,
Town Clerk.
Town Hall, Halifax,
12th April, 1930. 4851

PUBLIC NOTICES

AMENDED ADVERTISEMENT.

Borough of Worthing.
CORPORATION WATERWORKS.
TENDER FOR BORE-HOLE PUMP.

TENDERS are INVITED for ONE BORE-HOLE PUMP coupled to and driven by an ELECTRIC MOTOR, capable of delivering water at the rate of 60,000 gallons per hour.

Specification and form of Tender can be obtained on application to the Borough Water Engineer, Chapel-road, Worthing.

Tenders, endorsed "Tender for Bore-hole Pump," must be delivered to the undersigned, not later than 5 p.m. on Monday, 28th April, 1930.

J. KENNEDY ALLERTON,
Town Clerk.
Municipal Offices, Worthing,
5th April, 1930. 4795

City of Nottingham.
ALFRETON-ROAD DIVERSION—BOBBERS MILL.
BRIDGE OVER L.M. & S. RAILWAY, CONTRACT NO. 1.
BRIDGE OVER RIVER LEEN.—CONTRACT NO. 2.
TO CONTRACTORS.

The Improvement Committee is prepared to receive TENDERS for the CONSTRUCTION of the above BRIDGES, consisting of Concrete and Brick Abutments, Piers and Wing Walls, Brick Jack Arches, &c.

Drawings may be seen and copies of the general conditions of contracts, specifications, bills of quantities, and forms of Tender may be obtained on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of £1 for each contract, which will be returned on receipt of bona fide Tenders.

Sealed Tenders, in the official envelopes provided, are to be delivered to the undersigned not later than 6 p.m. on Tuesday, May 13th, 1930.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from firms who conform to the conditions of the contracts with regard to paying the local standard rate of wages, &c., and to the working rules of the Nottingham district.

By Order,
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
14th April, 1930. 4852

City of Nottingham.
ALFRETON-ROAD DIVERSION—BOBBERS MILL.
BRIDGE OVER L.M. & S. RAILWAY—CONTRACT NO. 3.
BRIDGE OVER RIVER LEEN—CONTRACT NO. 4.
TO STRUCTURAL ENGINEERS.

The Improvement Committee is prepared to receive TENDERS for the CONSTRUCTION of the above BRIDGES :—

CONTRACT NO. 3.—About 121 Tons of Steel Work in Plate Girders, Stanchions, Cross Bracing, Floor Ties, &c.

CONTRACT NO. 4.—About 28 Tons of Steel Work in Compound Girders, Floor Ties, &c.

Drawings may be seen and copies of the general conditions of contract, specification, bills of quantities, and forms of Tender may be obtained on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of £1 for each contract, which will be returned on receipt of bona fide Tenders.

Sealed Tenders are to be delivered to the undersigned in the official envelopes provided not later than 6 p.m. on Tuesday, May 13th, 1930.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from firms who conform to the conditions of the contracts as regards paying the local standard rate of wages, &c., and to the working rules of the Nottingham district.

By Order,
W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
14th April, 1930. 4853

ENGINEERING AND MACHINE TOOL MAKING BUSINESS FOR SALE BY PRIVATE BARGAIN.

The Subscribers are Prepared to receive OFFERS as a GOING CONCERN for the OLD-ESTABLISHED BUSINESS (including Goodwill, Ground, Buildings, Plant, Machinery, Drawings, Patterns, Patents, Stock, &c.) belonging to CLIFTON and WADDELL, LAIGHCARTSIDE WORKS, JOHNSTONE.

The Works, which are situated conveniently to the L.M.S. Railway Sidings, cover an area of approximately 3600 square yards. They include Machine, Erecting, and Pattern Shops, Stores and Offices.

The firm is engaged in the manufacture of Metal Sawing and Allied Machinery and has been established for 32 years, having a valuable connection amongst Structural and General Engineers, Steel Works, Shipyards, &c.

Intending purchasers may view the works, machinery and plant by arrangement with the Subscribers, who will furnish full particulars.

THOMSON McLINTOCK & CO.,
Chartered Accountants.
216, West George-street, Glasgow,
14th April, 1930. 4854

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PUBLIC NOTICES

Harris Institute, Preston.

The Council of the Harris Institute invite APPLICATIONS for the POST of FULL-TIME ASSISTANT TEACHER in the Engineering Department and Junior Technical School. The appointment will date from September 1st, 1930.

Salary in accordance with the Burnham Scale for Technical Teachers.

Form of application may be obtained from the undersigned, to whom the completed form, together with copies of testimonials, should be returned not later than May 2nd, 1930.

E. C. MOYLE,
Principal and Secretary.
P6919

Municipal Corporation of Rangoon, Burma.

APPOINTMENT OF EXECUTIVE ENGINEER.

APPLICATIONS are INVITED for a POST of EXECUTIVE ENGINEER, to be under the Chief Engineer of the Corporation of Rangoon.

AGE.—Preferably between 35 and 40.

QUALIFICATIONS.—Candidates must be Members or Associate Members of the Institution of Civil Engineers or hold the Testamur of the Institution of Municipal and County Engineers or other equivalent qualifications.

EXPERIENCE.—Candidates should have previous municipal experience, especially in connection with the control and administration of large water supply and sewerage systems.

SALARY.—Rs. 1200 for the first year, rising by annual increments of Rs. 100 to Rs. 1700 per month, plus an overseas allowance of Rs. 150 per month and a motor car allowance. The Officer appointed will be eligible to subscribe to the Municipal Provident Fund if he elects to become a subscriber. Subscriptions are payable at the rate of one-twelfth of salary, and an equal amount is contributed by the Municipal Corporation. No exchange compensation will be allowed.

The appointment will be on agreement for a period of five years, subject to a probationary period of one year. A free first-class passage to Rangoon will be provided and leave and leave allowances will be in accordance with the Fundamental Rules applicable to Officers in superior service under the Government of India.

Further particulars may be obtained from the undersigned by forwarding an addressed envelope to them and by whom applications will be received up to the 30th April, 1930.

OGILVY GILLANDERS & CO.
(Reference R3138),
4767 32, Old Jewry, London, E.C. 2.

The National Boiler and General Insurance Co., Ltd.,

St. Mary's Parsonage, Manchester, REQUIRE additional INSPECTORS in the Lift and Crane Department. Applicants should be between 25 and 35 years of age and be prepared to reside in any part of the country; must be practical engineers with actual experience in construction, erection and repair of Lifts and Cranes; also must have recognised theoretical qualifications and be able to make dimensioned sketches. Duties include the examination and tests of all classes of lifts, cranes and other lifting appliances. Salary to commence £260 per annum.—Apply in own handwriting, by letter only, marked "Lift and Crane Inspector," giving age, outline of practical training and experience, particulars of theoretical training, and copies of testimonials, to EDWARD G. HILLER, Chief Engineer and General Manager. 4838

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ASSISTANT MECHANICAL ENGINEER for Egypt, age 26 to 32, single; University Degree or A.M.I.C.E. Strict medical examination. Shop and drawing-office experience essential. Commencing salary £550.—Write, enclosing copies only of testimonials, details of experience and of education, EGYPTIAN DREDGING COMPANY, 17, Sharia Kasr-el-Nil, Cairo. P6917 A

WANTED for a Cotton Spinning and Weaving Mill in India, an experienced GENERAL MILLWRIGHT, age 30 to 36 years, capable of taking charge of all Gearing and Mechanics' Shop Work. Five years' agreement, first year's salary 600 rupees per month, rising 25 rupees yearly to 700 rupees per month for the fifth year. Second-class passages paid out and home. Single man preferred, but not essential. Must be of strictly sober habits. State age, experience, and give references. Interviews early May.
Address, P6911, The Engineer Office. P6911 A

ASSISTANT MANAGER, Experienced in Mechanical and Structural Engineering, for small works in the South of England. Confidential position. Must invest £200, secured. State experience and salary expected.—Address, P6920, The Engineer Office. P6920 A

CHIEF AGENT WANTED by First-class Firm of Contractors who have in view a very large dock contract abroad. Candidates must have had exceptional experience and should write fullest particulars of recent employment, age, &c.—Address, P6901, The Engineer Office. P6901 A

HIGHLY Qualified PRACTICAL and TECHNICAL ENGINEERS REQUIRED to Prepare Written Lectures in Advanced Heat Engines and Workshop Practice. Spare time only. Send particulars of experience, &c.—Address, P6908, The Engineer Office. P6908 A

INDIA.—WANTED, Capable SALES ENGINEER, to Take Charge of Sales Organisation for Power Plant, Air, Oil, Steam and Gas. State sales experience, which is absolutely essential; also state age, technical training, and works experience.—Address, 4841, The Engineer Office. 4841 A

MANAGING DIRECTOR of Works in Yorkshire REQUIRES ASSISTANT, aged 25-30. Must be well educated, capable, resourceful, and willing to take responsibility. Knowledge of Petrol Motors and Electrical Machinery essential and Foundry experience desirable. A permanent post for good all-round man. First-class references required.—Address, stating age, experience, &c., P6909, The Engineer Office. P6909 A

MECHANICAL ENGINEER, with Thorough Practical experience in Steam, Gas and Oil-driven Heavy Pumping Plant, REQUIRED for the post of Resident Engineer in charge of maintenance and distribution, for Water Company in a growing district in the Southern Home Counties. Commencing salary £450 per annum with house, coal and light.—Address applications, stating age, education, training and experience, 4863, The Engineer Office. 4863 A

PUBLICITY DEPARTMENT REQUIRES the SERVICES of a young and energetic ASSISTANT with engineering training, good education and journalistic ability. Experience desirable. Progressive position.—Apply, with full particulars of career, age and salary required, to PUBLICATIONS, c/o The English Electric Co., Ltd., Queen's House, Kingsway, W.C. 2. 4845 A

REFRIGERATING ENGINEER, with Abattoir experience, REQUIRED, to Take Charge of Cold Storage and Abattoir Plant in South Africa. Only a fully experienced man should apply, giving full particulars, to Box L996, c/o Dawsons, 118, Cannon-street, E.C. 4. 4862 A

VACANCY for ARTICLED PUPIL in the Office of the Chief Engineer of the Metropolitan Water Board.—Particulars as to premium and conditions may be obtained from Mr. HENRY E. STILGOE, M. Inst. C.E., the Chief Engineer, to whom applications should be addressed at the offices of the Board, 173, Rosebery-avenue, E.C. 1. 4825 A

WANTED, DRAUGHTSMAN, Experienced in the Design of Combined Superheated Steam Engines and Boilers, district East Midlands. State age, experience and salary required.—Address, 4799, The Engineer Office. 4799 A

SITUATIONS OPEN (continued)

DRAUGHTSMEN REQUIRED by CREED and CO., Telegraph Engineers, Croydon, for development work in connection with high-speed electro-mechanical instruments for mass production similar to electric typewriters and the like. Must be capable of good clean rapid work. Preference given to young men with sound technical training and designing ability.—Write, stating age, experience, and salary required; application to be marked "Development." 4832 A

DRAUGHTSMAN REQUIRED, Experienced in Small Tools and applications to Modern Machine Tools and General Mechanical Engineering.—Address, with full details of experience and technical abilities, 4850, The Engineer Office. 4850 A

DRAUGHTSMEN, Senior and Junior, REQUIRED for Metal-clad Switchgear. Good mechanical experience essential.
Apply, stating age, full experience, and salary required, to SWITCHGEAR DEPARTMENT, General Electric Company, Ltd., Witton, Birmingham. 4817 A

DRAUGHTSMEN, Senior, Possessing Sound Knowledge of Medium-size Power Transformers.—Address applications, giving particulars of experience, age, and salary required, 4754, The Engineer Office. 4754 A

DRAUGHTSMAN WANTED, East London, for development of Small Stationary Internal Combustion Engine. Must be experienced in modern practice.—Address, stating age, experience, and salary required, P6918, The Engineer Office. P6918 A

DRAUGHTSMEN WANTED, Fully Experienced Jig and Press Tool Designers. Must have first-class experience of Jigs, Press Tools and Production Equipment for Automobile Work. State age and experience.—Address, 4796, The Engineer Office. 4796 A

EXPERIENCED TEMPORARY DRAUGHTSMAN, to Assist in the Completion of Plans of Reservoirs and Subsidiary Works under the direction of the Resident Engineer. Wages Six Guineas per week.—Applications, stating age and experience, accompanied by copies of recent testimonials, to be addressed to the GENERAL MANAGER, Water Department, Sheffield. 4801 A

JUNIOR DRAUGHTSMAN REQUIRED by a Firm of Constructional Engineers in London.—Address, stating age, experience, and salary required, P6914, The Engineer Office. P6914 A

LARGE OIL ENGINE BUILDERS REQUIRE JIG and TOOL DRAUGHTSMEN.—Address, giving full particulars of experience, age, and salary required, 4857, The Engineer Office. 4857 A

SITUATIONS WANTED

ADVERTISER, with Successful Record as Works manager, shop superintendent and planning engineer, is OPEN for APPOINTMENT with a concern desirous of improving manufacturing methods, increasing production and reducing costs.—Address, P6889, The Engineer Office. P6889 B

ENGINEER (30) SEEKS CHANGE. Public School education, exp. shops, D.O., assistant engineer, works extensions and maintenance.—B.M./L024, London, W.C. 1. P6887 B

STRUCTURAL ENGINEER, Age 28, Single, REQUIRES POST as FOREMAN or ASSISTANT ERECTOR, any part abroad; 12 years' experience England and 20 months India. Excellent testimonials.—Address, P6912, The Engineer Office. P6912 B

TO ELECTRICAL and MECHANICAL ENGINEERS.—Trained engineer having specialised for the past 16 years on scientific purchasing and modern practice in store keeping and accounting with important organisations, DESIRES CHANGE. Keen, energetic and economical worker; thorough knowledge of world's markets. Good organiser and able to control staff and working force so as to obtain best results from team work. Highest credentials.
Address, P6886, The Engineer Office. P6886 B

PARTNERSHIPS

PARTNERSHIPS.—Business Men in Need of Further WORKING CAPITAL and have no objection to a Private Limited Liability Company (sound propositions or Patents entertained), Write or 'Phone Holborn 5048.—RAY and RUSSELL, 88, Chancery-lane, London, W.C. 2. P6913 C

AGENCIES

AGENT REQUIRED by Well-known London House for Rolling Shutters, Steel and Wood; all types and for all purposes. One with good connection among architects and builders preferred. Area required, Bristol, South Wales and area around Bristol.—Address, 4858, The Engineer Office. 4858 D

MARSHALL, SONS and CO. (INDIA), Ltd., who have an old-established Engineering and Merchant Business in India, with works at Calcutta and offices and godowns in Calcutta, Bombay, Madras, Karachi, Lahore, Tanjore, Coimbatore, Bezwada, &c., are WILLING to UNDERTAKE the REPRESENTATION in India of ONE or TWO ENGLISH COMPANIES of good standing who already do a direct business with India. M., S. and Co. (India), Ltd., have a staff of European Managers, Engineers, and Salesmen at each of the important business centres in India and are able to render efficient representation services, accommodate stocks, and act for companies in connection with the tendering for and supply of goods to the Indian Stores Department. The new rules which will shortly come into operation render it highly desirable that firms wishing to increase their business in India should carry stocks and have representation there.—Address communications to J. HUGH MARSHALL and PARTNERS, Gainsborough. 4846 D

AGENCIES

WELL-KNOWN American SALES ENGINEER, connected with strong national sales organisation, now visiting London, DESIRES to COMMUNICATE with FIRM or INDIVIDUAL having article of merit for manufacture and sale in the United States and Canada.—Address, P6907, The Engineer Office. P6907 D

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Correspondence Courses

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are personally conducted by

Mr. Trevor W. Phillips,

B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.

For full particulars and advice apply to:—36, DALE-STREET, LIVERPOOL (Tel., Bank 1118). LONDON OFFICE: 65, CHANCERY-LANE, W.C. 2. Ex.

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MISCELLANEOUS

ENGINEERS

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22, SHAKESPEARE HOUSE, 29, OXFORD STREET, LONDON, W. 1.
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The Metallurgist

"The Metallurgist" is a free supplement accompanying the last issue of "The Engineer" for each month.

It is devoted entirely to the science and practice of Metallurgy—ferrous and non-ferrous.

The following comments by a few of our readers indicate its usefulness in a field hitherto much neglected.

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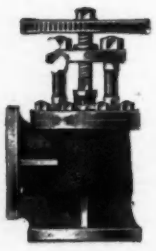

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A Seven-Day Journal

Charing Cross Bridge and the New Station.

ON Thursday of last week, April 10th, the Private Bill Committee of the House of Commons, which, since March 25th, has had under its consideration the London County Council (Charing Cross Bridge) Bill, announced that it took exception to the riverside site proposed for the new terminal station and that its sittings would be adjourned until May 6th in order to allow that part of the Bill to be reconsidered. Sir Henry Cautley, the Chairman of the Committee, stated that while the Committee approved of the scheme as far as it concerned the north side of the river, subject to the widening of St. Martin's-lane, it could not accept the placing of the proposed new terminal station at the bridge head, with the arrangement of roads, tunnels and blank walls which the model showed. It would not be fair, he said, to hold up the whole of the future development of the site by putting the railway station in the position which had been chosen. If the station were to be placed further back from the river there would be, the Committee considered, more opportunity for turntable and coaling arrangements. Early in the present week a conference between the Ministry of Transport, the Southern Railway Company and the London County Council took place to consider the views expressed by the House of Commons Committee. It is hoped that a satisfactory position for the new station will be found within the desired area.

Rationalisation in British Shipbuilding.

BRIEF reference has already been made in our columns to the National Shipbuilders' Security, Ltd., the £10,000 company with large borrowing powers, which was founded in February last with a view to eliminating redundant and obsolete shipyards and securing a reduction in cost by the concentration of production. The articles of association of the new company and the names of its directors have now been announced. The chairman is Sir James Lithgow, who is also the new president of the Federation of British Industries, a member of the Electricity Board and a past-president of the National Confederation of Employers' Organisations. The board of directors includes representatives of most of the important shipbuilding firms. The names of the directors are: Mr. A. L. Ayre, of the Burntisland Shipbuilding Company, Ltd.; Mr. John Barr, of Vickers, Ltd., Barrow, and Commander Craven, of Vickers, Ltd., and Vickers-Armstrongs, Ltd.; Mr. J. W. Kempster, of Harland and Wolff, Ltd.; Sir Alexander Kennedy, of Fairfield, Doxford's, and the Northumberland Shipbuilding Company, Ltd.; Mr. F. C. Pyman, of William Gray and Co., Ltd.; Mr. A. M. Stephen, of Alexander Stephen and Son, Ltd.; Mr. T. E. Thirlaway, of Swan Hunter and Wigham Richardson, Ltd., and Barclay, Curle and Co., Ltd., and Mr. R. N. Thompson, of J. L. Thompson and Son, Ltd., and Sir James Laing and Sons, Ltd. This large board was considered necessary in order that all types of shipbuilding and all districts might, as far as possible, be represented. The board of directors above-named will form the executive of the company, and with its formation the company is now in a position to begin its work.

Science and the Labour Party.

POSSIBLY through lack of observation on our part we had not until this week noticed the existence of a body called the Science Advisory Committee of the Labour Party. Precisely with what duties this body is charged we still do not know. All the information concerning its activities at present in our possession is summed up in the fact that last week it sent a deputation to wait on Lord Parmoor, as Lord President of the Council, for the purpose of submitting suggestions for the development of industrial research in this country. Lord Parmoor's reply consisted of a brief but admirable summary of the work being done by the Department of Scientific and Industrial Research. There is evidence that the Science Advisory Committee of the Labour Party has heard of the existence of the Department. There is, however, little or no indication that it has made itself acquainted even cursorily with the Department's aims, organisation and achievements. The Committee was anxious to see the Department undertaking work of national importance. Lord Parmoor had no difficulty in showing that it was already carrying on such work on an extensive scale as regarded man's primary needs in the matter of food, fuel, habitation and clothing, and that it was helping to cultivate the arts of living by its work on wood and minerals. The Science Advisory Committee desired to see increased co-operation between the scientific staffs in the various Government services. Lord Parmoor made the obvious reply. The Department's Co-ordinating Research Boards had been set up for that very purpose, and so well had they done their work that they had now been dissolved. The Committee in the third place desired to see the establishment of an effective channel of communication between scientific workers and industry. Lord Parmoor naturally drew its attention to the Research Associations established with the assistance of the Department and the direct contact between industry and scientific workers, which was one of their primary functions. We cannot understand either the objects or the outlook of the Science Advisory Committee.

Armed Merchantmen and Submarines.

NAVAL experts in France are puzzled to know what to do with the proposed restrictions on submarines. Although big submarines lack handiness and are too conspicuous to fulfill all the requirements demanded of underwater craft, they are, nevertheless, regarded as essential to a country possessing few naval bases, and the idea of limiting the number of vessels of the "Surcouf" class to three does not meet with French approval. Objection is even stronger to the arming of the smaller submarines with guns of a maximum calibre of 5in. This restriction, it is claimed, will place the submarine at the mercy of fast liners, which, with their superior armament and speed, could compel the underwater vessel to submerge and disappear. While Great Britain possesses 208 ships of from 6000 to 30,000 tons capable of steaming at 15 knots at least and eight liners of greater tonnage that can steam at 20 knots or over, France has only two ships of the latter class. Her inferiority in this respect is manifest when compared not only with Great Britain, but also with Italy. By arming her merchantmen Great Britain, it is said, escapes the consequences of parity and the reduction of her navy. The French declare that they cannot accept the proposed compromise. The discussion tends to show that a reduction of naval armaments may be followed by further competition in the building of big and fast merchantmen that will become formidable auxiliaries in time of war.

Welfare Work at the B.T.H. Works.

ON Tuesday afternoon, April 8th, his Royal Highness the Duke of York, who is President of the Industrial Welfare Society, visited the Rugby works of the British Thomson-Houston Company. Accompanied by Mr. Robert Hyde, Director of the Society, he inspected various departments of the factory, which at the present time provides employment for approximately 7000 people. A feature of the tour was the presentation to his Royal Higness of workers with long service. About 20 per cent. of the workers are women, who are looked after by a lady superintendent. Considerable attention has been devoted to the problem of guarding their welfare by the provision of appliances to ease the strain of the individual worker; by the introduction of suitable benches and backed chairs; by giving careful attention to the general tidiness and cleanliness of the departments; and by introducing into some of these departments a colour scheme to brighten the working conditions. In the Mazda electric lamp factory girls are taken for training at the age of sixteen and in about three months become skilled operators, capable of carrying out very delicate operations and of manufacturing complex machines. Boys from elementary, junior technical, or lower secondary schools are usually engaged for a period of one year as office or utility boys in one of the works or office departments before beginning their apprenticeship, in order that they may gain some idea of life in a big industrial works. After this period a lad undergoes a six months' trial in the apprentice department, where the apprentice supervisor is afforded an opportunity of studying his characteristics and ability, and in due course the boy's parents are given advice. The boy may be apprenticed to a trade or he may go into the drawing-office. The trade course trains the boy with a view to making him a skilled artisan, and should he subsequently show the necessary ability, he may become a charge hand, inspector or rate-fixer. Boys who show exceptional ability while undergoing their trade course are eligible for transfer to the drawing-office or engineering apprentice course, and similarly drawing-office apprentices showing exceptional ability may be transferred to the engineering apprentice course.

Synthetic Atoms.

IT is not very easy to follow the reports received from America within the past few days to the effect that Professor William D. Harkins, of the University of Chicago, has succeeded after seven years of experiment in synthesising atoms. The reports are as yet incomplete and appear to be garbled. Professor Harkins gave an account of his experiments to the American Chemical Society. We gather that he discharged the alpha particles of helium, produced by the disintegration of thorium, through a glass cylinder containing nitrogen supersaturated with water vapour. The paths of the alpha particles were rendered visible by the production of threads of condensed water vapour. These threads were illuminated and photographed. Each photograph showed an average of about twelve threads. After taking 10,000 photographs he found one in which one of the threads stopped abruptly and split into two. After 34,000 photographs had been taken he found another showing the same phenomenon. From the thickness, length and direction of the split threads he was able to determine that the bifurcation represented the collision of an alpha particle with a nitrogen atom and the formation of an atom of oxygen and an atom of another element variously given as fluorine, hydrogen or nitrogen. Those interested in the subject may find it useful to know that the international atomic weights of the elements mentioned are:—Hydrogen, 1·0077; helium, 4·00; nitrogen, 14·008; oxygen, 16·000; fluorine, 19·00. From these figures it would appear to be just about arithmetically possible for the union of a helium and a nitrogen atom to give rise to two atoms of hydrogen and one atom of oxygen. It is, however, difficult to see how the union could produce fluorine even momentarily. In any event the novelty of Professor Harkins' investigation has yet to be made clear. In 1919 Rutherford showed that the nuclei of nitrogen atoms could be transformed by bombardment with the alpha particles emitted by radium, the alpha particle being captured by the nitrogen in the process and the mass of the resulting atom being greater than before. Professor Harkins seems to have obtained two direct hits in some 400,000 chances. Rutherford has estimated the probability of a hit at twice this figure, namely, 1 in 100,000. Modern views as to the structure of the atom do not seem to be challenged in any way by the results reported to have been obtained by Professor Harkins.

Retirement of Mr. H. A. Reed.

THE retirement of Mr. Henry Ashman Reed from the position of chief engineer to the Manchester Ship Canal Company is announced. His connection with the waterway dates back to the days of its construction, when he was a sectional engineer under the contractor. Earlier experience on Gibraltar harbour works and on Southampton deep-water docks construction, together with many years' experience of ship canal work, gained for Mr. Reed a wide reputation as an authority on port works, and from time to time many claims have been made on his expert knowledge. At the request of the British Foreign Office he became a member of the International Technical Committee which inspected the Rhine in 1924 and 1929. In 1926 he was a British delegate to the Navigation Congress in Cairo, whilst in 1915 he acted as adviser to the War Office on the port of Richborough. At the present time he is on the Suez Canal Consultative Works Commission. Two years ago the Egyptian Government invited Mr. Reed to visit Egypt to act as expert adviser on inland waterways, and during the following year he was appointed a member of the International Commission on the River Congo. During his eighteen years' service as chief engineer to the Manchester Ship Canal Company Mr. Reed has been responsible for a great deal of important development and construction work. The deepening of the lower reaches of the canal, the construction of the Stanlow oil dock and No. 2 grain elevator, new transit sheds and works of reconstruction, representing an expenditure of about three million pounds, were carried out during his term of service. In relinquishing the post of chief engineer and devoting himself to consultative work in London Mr. Reed does not withdraw the benefits of his experience from the Canal Company, for he will still be at the disposal of the undertaking as a consultant. Mr. Fred Berry Greenwood, who joined the staff of the Ship Canal Company in 1895, under the late Mr. W. H. Hunter, then chief engineer, succeeds Mr. Reed. In 1901 he was appointed resident engineer of the tidal division of the Ship Canal, and in 1911 became assistant engineer to the company.

The British Airship R 100.

THE two British airships "R 100" and "R 101" have not been seen by the public since the end of last year. As is well known, the "R 101" is undergoing extensive alterations, including the insertion of an additional panel into her length, and other changes designed to increase her lifting capacity. The "R 100" is being prepared for a flight to Canada, which, according to present intentions, will take place next month. It is announced by the Air Ministry that many applications have been received for passages or for the conveyance of freight on that trip. The flight is, however, to be an official experiment, and no ordinary passengers or freight will be carried during it by the airship. Not even mails will be carried. The decision to exclude passengers, goods, and mails on this first flight is undoubtedly a wise one from all points of view. Many scientific observations will doubtlessly be made on the trip, and much recording and measuring gear will have to be carried, together with a staff of observers. Further, it should be noted that the actual mooring of an airship at the St. Hubert Tower in Canada has not as yet been carried out, although the mooring gear has been tested as far as it possibly can be in the absence of an airship. We described the tower in our issue of March 28th. Structurally it is similar to the tower at Cardington, but it differs from the Bedfordshire example in the fact that the tower-head machinery is operated by means of compressed air instead of electrically.

The Automatic Stabilisation of Ships.

No. III.*

THE Frahm anti-rolling tank system in the form originally evolved and applied by the inventor is illustrated in Fig. 2. It makes use of two wing chambers S connected at their lowest level by an athwartship passage H and at their highest level by a second athwartship passage L, in which a valve D is

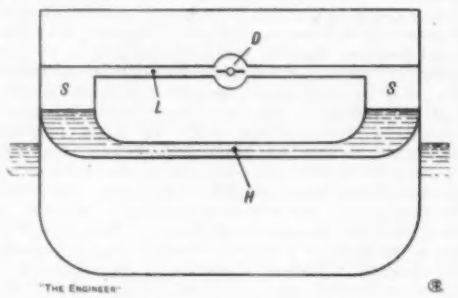

FIG. 2—THE ORIGINAL FRAHM SYSTEM

situated. The chambers and the passage H are half-filled with water. The upper halves of the chambers and the passage L are air-tight.

In effect the system is equivalent to a U-tube partially filled with liquid. If the liquid in such a tube is set into motion it will oscillate with a period given by $T = 2\pi\sqrt{\frac{l}{2g}}$, where l is the length of the liquid column considered as straight and of uniform cross section. This expression only applies if the motion of the liquid is unresisted. Even in the simplest U-tube the resistance is considerable. With resistance present the period of oscillation can be expressed by $T = 2\pi\sqrt{\frac{l}{2g - kA}}$, where kA is a term proportional to the resistance k. It will be noted that resistance always lengthens the period and that by controlling the resistance we can regulate the period to any desired amount. This fact is recognised in the design of astronomical clocks, the pendulum cases of which are made air-tight in order that the pendulum may oscillate in air of a constant density and therefore be exposed to a constant air resistance.

The period of oscillation of the water in the Frahm anti-rolling tank system is adjusted by means of the air valve, which, by applying resistance to the enclosed air, likewise applies it to the water. The period is adjusted until it is substantially equal to the natural period of oscillation of the ship as loaded for the voyage. In action, the rolling of the vessel sets the water into oscillation in the same period as that possessed by the ship, but lagging in phase a quarter of a period behind the rolling of the vessel. Since the water lags behind the motion of the ship by a quarter of a period it follows that when the ship is full out to port, as at A, Fig. 3, the water is at the mid-point of its swing; that is to say, the amount of water is the same in both tanks. At this instant the vessel has finished a roll to port. It may be represented by a pendulum in the position indicated at B. Subtracting a quarter of a period we may represent the water by a second pendulum C at the mid-point of its swing and about to move over to port. A quarter of a period later the vessel is upright and the water, as indicated, has risen in the port tank and fallen in the starboard. The vessel is moving towards starboard and the water, having reached its highest level in the port tank, is about to reverse the direction of its flow. Another quarter of a period later the vessel is at the extreme starboard end of her roll and the flow of water from the port to the starboard tank will have just resulted in equalising the weight of water in the two tanks. After another quarter of a period has elapsed the vessel will again be upright, but will be moving towards port. The flow of water will have continued from the port to the starboard tank, and, as a consequence, at that instant the water will have reached its maximum height in the starboard tank and be about to reverse the direction of its flow. The next quarter period sees the conditions restored to those indicated at A.

It will be observed that in the two extreme out positions the water is distributed equally between the two tanks. So distributed, its weight neither assists nor retards the rolling of the vessel except in so far as its mere mass adds to the vessel's normal moment of inertia. In the vertical positions, however, the bulk of the water is in one or other of the tanks, namely, in the port tank when the ship is about to roll to starboard, and in the starboard tank when she is about to roll to port. So distributed, the weight of the water clearly acts to counter the rolling of the vessel.

It is not desirable to think of the distribution of the water in only four selected positions of the vessel. Its motion throughout a complete roll should be studied. Starting with the extreme out port position, the water begins to accumulate in the port tank until the ship becomes vertical. During this quarter period the weight of the water is exercising an increasing effect. That effect is in one way equivalent to a force holding the vessel back from recovering her vertical position. Otherwise regarded, however, it is a force which will diminish the velocity with which the ship will pass through the vertical position; that is to say, the velocity which during the next succeeding quarter period will carry her over to starboard. As the ship passes from the vertical to the extreme starboard position the surplus of water in the port tank diminishes until it disappears. In other words, as the starboardwise velocity of the ship diminishes the countering effect supplied by the water falls off. During the recovery of the vertical position from the extreme starboard end of the roll the water accumulates in the starboard tank and consequently acts to lower the velocity with which the ship will pass through the vertical position, the velocity which subsequently will carry her over to port. With the fall of the water in the starboard tank as the ship swings from the vertical to the out port position the countering effect of the water diminishes proportionately with the rolling velocity.

It will be seen from this analysis of the action which takes place, that the function of the water is, in effect, to diminish the velocity which the ship possesses as she passes through the vertical position in either direction.

The range through which the water oscillates is naturally determined by the amplitude of the ship's rolling or more precisely by the magnitude of the first roll, which sets up the initial oscillation of the water. The stabilising effect of the system is zero until the ship begins to roll and increases with the violence of the rolling. If the ship floating in still water is heeled over and released, the tank action will be at once manifested and will decrease its effect as the vessel oscillates in diminishing arcs towards rest. At sea if the vessel is exposed to successive rolling impulses at regular or irregular intervals, the tank action will increase or diminish its stabilising effect in accordance with the response of the vessel to the rolling impulses. The system does not and cannot eliminate all rolling motion, nor in general does it reduce the rolling to some constant amplitude. In Fig. 4 we reproduce a curve showing the rolling of the Hamburg-America liner "Deutschland" on a run from New York to Hamburg on July 9th, 1924. At the time the record was taken there was a heavy sea, and the wind was 8 to 10 on the Beaufort scale. It will be seen that with the tanks out of action the ship rolled up to a maximum of 16 deg. of heel and that the rolls built themselves up and then decreased in the manner characteristic of a vessel exposed to waves of a period different from her own natural period. With the tanks in action the maximum roll was reduced to 5 deg. of heel. The rolling was not completely eliminated, and still showed traces of cyclical increases and decreases.

The full theory of the Frahm tank system, in spite of the apparent simplicity of the above description of its action, is highly complex. The action, it will be observed, depends upon the fact that, at all amplitudes of rolling, the water in the tanks has a phase lag of a quarter of a period behind the motion of the ship. This lag is of a fundamental nature, and is not peculiar to the water tank system. It is dependent upon the fact that the water inside the tanks behaves like a pendulum and is directly deducible from the general laws governing the motion of pendulums.

If a pendulum consisting of a heavy bob and a cord is suspended from the roof of a railway coach, and if the coach is accelerated from rest at a uniform rate, the pendulum, so long as the acceleration is maintained, will exhibit a deflection from the vertical. The magnitude of this deflection will be a direct representation of the value of the acceleration. The angle of the deflection φ will be given by $\tan \varphi = \alpha/g$, where α is the acceleration in feet per second per second, and g is 32·2. As an example, starting from rest on the level track between Stonebridge Park

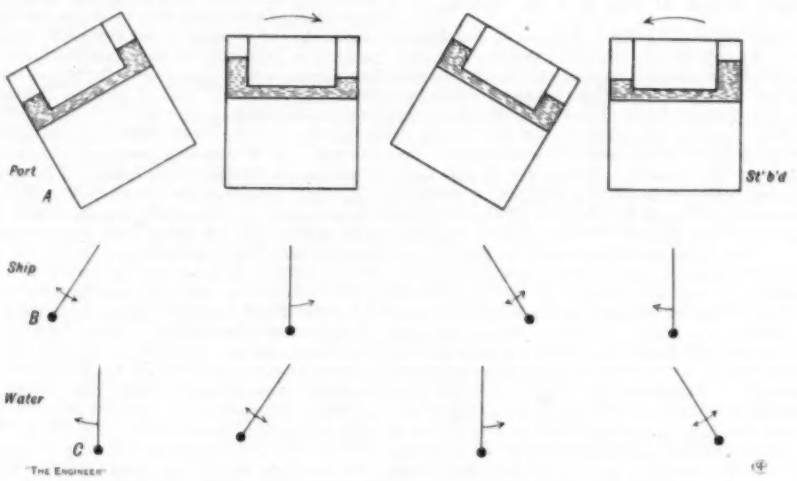

FIG. 3—ACTION OF THE FRAHM ANTI-ROLLING TANK SYSTEM

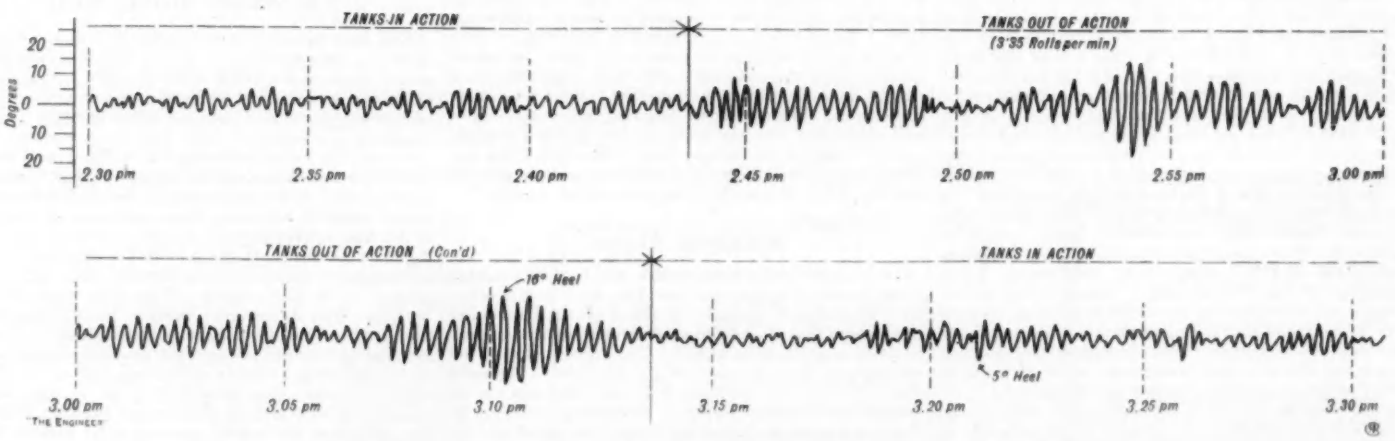

FIG. 4—ROLLING OF THE "DEUTSCHLAND" WITH HER TANKS IN AND OUT OF ACTION

* No. II. appeared April 11th.

and Harlesden, L.M.S. Railway, a three-coach electric train weighing 112 tons has been timed to acquire a speed of 25 miles an hour in 24 sec. The speed-time curve was practically straight during this period, and hence the acceleration was substantially constant and equal to 1·53ft. per second per second. Had a pendulum been suspended from the roof of one of the coaches, it would have exhibited a deflection from the vertical given by tan $\varphi = 1{\cdot}53/32{\cdot}2 = 0{\cdot}047$, so that the angle φ would have been about $2\frac{3}{4}$ deg.

The important fact to note is that the deflection is not acquired instantaneously. From the instant at which the acceleration starts until the deflection is fully developed, a period equal to one-quarter of the natural period of the pendulum elapses, no matter what length the pendulum may have. That some

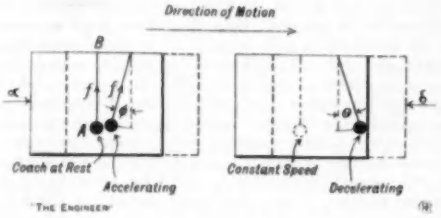

FIG. 5—A PENDULUM IN A MOVING BODY

interval of time elapses before the pendulum acquires its full deflection, φ, can readily be understood by considering the reason why the pendulum deflects at all. In Fig. 5, A B represents the pendulum at rest just before the acceleration α comes into action. The acceleration is the effect of force applied to the coach. This force is transmitted to every part of the coach including the point B. It cannot, however, be transmitted down the flexible cord to reappear as a horizontal force applied to the bob. It follows, therefore, that when the coach, including the point B, moves forward under the accelerating force, the bob remains behind in space because there is no force acting on it to move it forward. If, however, the point B moves forward while the bob remains still, the cord will acquire an inclination. With the development of the least inclination, the pull f in the cord will apply a horizontal component to the bob, which will cause the bob to begin to move forward. The force represented by this horizontal component is at first insufficient to accelerate the bob at the same rate as the point B is accelerating, and as a consequence the point B moves forward more quickly than the bob. This difference of velocity increases the angle of the cord. The horizontal component, therefore, also increases and the forward velocity of the bob in turn becomes greater. Clearly, a time will come when the horizontal component reaches a value which is sufficient to accelerate the bob at the rate α. When this time arrives the bob and the point B will move forward with the same velocity and the deflection of the pendulum will cease to increase. The angle φ, therefore, represents the motion lost by the bob while the horizontal component of the pull applied by the cord is developing from zero up to the value required to accelerate the bob at the same rate α as that at which the coach is being accelerated. This lost motion is never recovered so long as the acceleration persists. The limiting angle φ will, as we have said, be given by tan $\varphi = \alpha/g$, and the time occupied by the pendulum in acquiring it will be one-quarter of the natural period of the pendulum. The fact that the time required for the development of the full deflection φ is one-quarter of the natural period, follows from a mathematical investigation of the subject.

It is evident that, if after some time, the accelerating force on the coach is removed, and the coach travels forward with constant velocity, the pendulum will be unable to maintain its deflected position, and will seek the vertical. It will reach the vertical with a certain velocity which will cause it to swing in its natural period until friction, &c., damp out the motion. If, the pendulum having come again to rest, the coach is decelerated at a rate δ, then so long as the deceleration remains constant the pendulum will exhibit a deflection θ given by tan $\theta = \delta/g$ on the side of the vertical opposite to that of the former deflection φ. The time occupied by the pendulum in acquiring this deflection will, measuring from the instant at which the deceleration starts, again be one-quarter of the natural period of the pendulum.

These facts are directly applicable to the case of the Frahm anti-rolling tank system, for that system is, in effect, a liquid pendulum carried inside a vessel which, when rolling sets in, is constantly passing through a cycle of acceleration and deceleration. For the purposes of mathematical analysis the problem is complicated by the fact that the rolling motion of the vessel is not actually divisible into a period of uniform acceleration, a period of uniform velocity, and a period of uniform deceleration. During a roll from out-to-port to out-to-starboard the acceleration starts at a maximum value in the starboardwise direction and decreases at a uniform rate until it is zero, when the vessel reaches her mid position. Thereafter deceleration of the starboardwise motion sets in, the rate of deceleration increasing from zero to a maximum when the extreme out position to starboard is reached.

The dynamics of the Frahm system can be readily followed by considering the behaviour of a simple pendulum, the point of attachment of which is caused to execute harmonic motion in a straight line A O B, Fig. 6. We may assume that the acceleration, instead of decreasing progressively as the point of attachment moves from A to O, has some average constant value α, and that from O to B it has an equal average constant value of opposite sign. The actual maximum acceleration at A is given by $2\pi^2 a/T^2$, where a is the amplitude of the point of attachment and T is its periodic time. The average acceleration α should be taken not at half this value, but at $0{\cdot}7854$ $(= \pi/4)$ times the maximum acceleration. The natural periodic time of the pendulum is to be assumed equal to the period observed by the point of attachment in its oscillations between A and B.

The motion may be considered as starting when the point of attachment is at A and with the pendulum hanging vertically. From A to O the point of attachment is subjected to a constant acceleration α. The pendulum therefore seeks a position inclined to the vertical at an angle φ, which, as previously stated, will be given by tan $\varphi = \alpha/g$. It will take a time T/4 secs. to acquire that inclination. The full angle φ will therefore be developed just at the instant when the point of attachment reaches the mid-point O.

It is now moving, however, with a velocity, due to the fall from O G, which in T/4 secs. would carry it to the position A H. This leftwards deflection of 2φ develops while the point of attachment moves from A to O and is additional to the deflection φ in the same direction which the pendulum acquires by virtue of the acceleration α of the point of attachment between A and O. When, therefore, the point of attachment reaches O coming from the left for the second time the pendulum is inclined to the vertical at an angle 3φ, as shown at O J.

The process continues on these lines. It will be seen that each time the point of attachment reaches one or other of the ends A B the pendulum is vertical, and that each time it passes through the mid-point O the pendulum is inclined to the vertical at an angle which increases in accordance with the series φ, 2φ, 3φ, 4φ, . . .

Taking the average value of the acceleration as $\pi/4$ times the true maximum, the value of the angle φ, the inclination possessed by the pendulum when the point of attachment passes through O for the first time, is given by $\tan \varphi = \alpha/g = \frac{\pi}{4} \cdot \frac{2\pi^2 a}{T^2 g} = \frac{\pi^3 a}{2T^2 g}$. This result is in agreement with exact mathematical analysis. That analysis shows, however, that the subsequent angles of deflection should be, not as given above, but 3φ, 5φ, 7φ, . . .

Comparing Figs. 6 and 3, it will be seen that the motion stated to occur in the water of the Frahm tanks is in agreement with the motion which the pendulum under the specified conditions has been demonstrated to possess. It is evident that, if a vessel fitted with Frahm tanks were to roll with a constant amplitude, the water in the tanks, being adjusted to the ship's period, would oscillate with an ever-increasing amplitude. In an actual vessel, however, the oscillation of the water would be a bar to the ship's rolling with a constant amplitude. The movement of the water would reduce the rolling amplitude and the reduction in the amplitude of the ship would reduce the amplitude of the water and prevent it from building up progressively in the manner suggested. We may picture the action taking place by supposing that in Fig. 6 the amplitude A of the point of attachment is in some way governed by the deflection of the pendulum at the mid-point, the arrangement being such that any increase in the pendulum deflection is immediately countered by a reduction in the amplitude of the point of attachment.

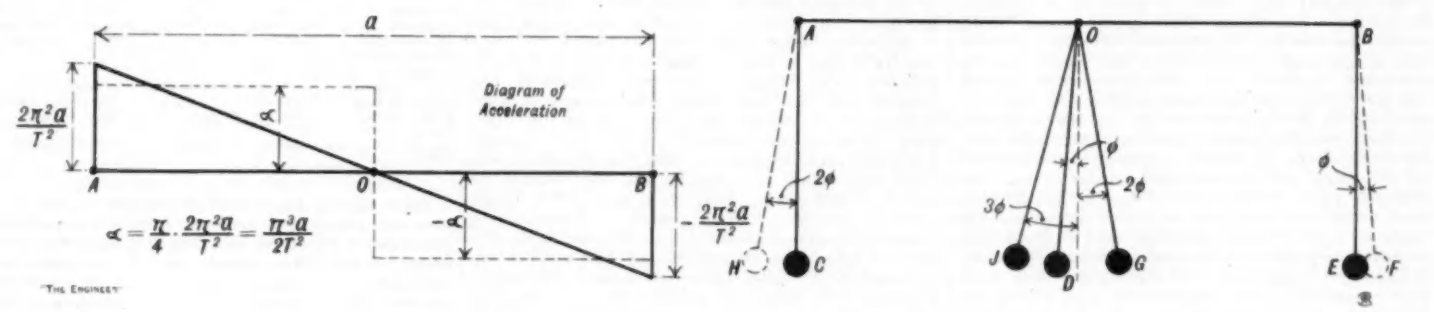

FIG. 6—THE DYNAMICS OF THE FRAHM SYSTEM

The pendulum during this interval will therefore move from the position A C to the position O D. As the point of attachment moves from O to B it is subjected to a deceleration α. The pendulum ought, therefore, to seek a new resting position inclined at the angle φ on the opposite side of the vertical to that shown at O D. Before it can begin to build up that inclination, however, it has to fall from the position O D to the vertical. Since its natural period is T, the time required for it to fall from O D to the vertical is T/4 secs.; that is to say, precisely the time taken by the point of attachment to move from O to B. It is evident, therefore, that when the point of attachment reaches B the pendulum is just again vertical as at B E and has not begun to build up the inclination φ appropriate to the deceleration α.

The point of attachment now begins to move back from B to O with an acceleration α. Although the pendulum is once again vertical, the conditions are not quite the same as those which prevailed at A. The pendulum at A C was stationary. At B E it possesses, by virtue of its fall from the position O D, a stock of kinetic energy which would, if the point of attachment remained stationary at B, carry the pendulum to the position B F in a time T/4 secs. This inclination φ to the right of the vertical develops, while the point of attachment moves from B to O and is additional to the inclination of equal amount and in the same direction which the pendulum acquires by virtue of the leftwards acceleration α possessed by the point of attachment between B and O. When the point of attachment reaches O the pendulum is therefore inclined at an angle 2φ to the vertical, as shown at O G.

The acceleration now changes to a deceleration α, but before the pendulum can develop the leftwards inclination φ appropriate to that deceleration it has to fall through the angle 2φ. It requires T/4 secs. to execute that fall, and consequently when the point of attachment reaches A the pendulum is just again vertical.

Institution of Naval Architects.

No. II.*

AT the afternoon session on Wednesday, April 9th, a paper by Engineer-Captain J. Hope Harrison, R.N., entitled "Some Materials Used for Naval Engineering Purposes" was considered. An abstract of it is given on page 440.

MATERIALS FOR NAVAL ENGINEERING.

Dr. W. H. Hatfield (Brown-Firth Laboratories, Sheffield), referring to steel for boiler tubes, said that rimming steel was subject to the residual effects of blow-holes which existed in the steel in the first place in ingot form, and he was quite sure that the Admiralty decision to adopt solid steel for boiler tubes was extremely sound. At the same time, rimming steel had the intrinsic advantage that the outer layer of the ingot, which froze first, had a very low carbon content, and it was conceivable that that outer covering, with low carbon content, might even assist the tube from the resistance point of view. Thus, there were two sides to the problem, and it would be interesting to see what happened, though he expected that the solid steel would prove to be the best. With regard to turbines, he agreed with Captain Hope Harrison that the trouble which had been experienced with the blading, and particularly with rustless steel blading, was due in the first place to indifferent fabrication, and, in the second place, to undue vibration, and was not caused by the intrinsic characteris-

* No. I. appeared April 11th.

tics of the material. He was rather surprised, however, that so much stress had been laid on the A.T.V. material. Steel makers were able to say a long time ago that over 1000 tons of the first stainless steels were in use in the form of blades, and were successful, whereas he believed it would be an exaggeration to say that as many hundredweights of the A.T.V. type of material were being so used. It was fairly clear that insufficient time had elapsed for the proper exploration of the characteristics of the chrome rustless steels, as distinct from the high nickel steels to which a little chromium had been added, to enable us to be dogmatic. With regard to forgings, he was surprised by the statement in the paper that, at the moment, the distrust of very high tensile alloy steels on account of the lack of homogeneity had almost resulted in a return to a low-carbon steel even at the expense of greatly increased weight. Surely there was something wrong there, because the armour, the gun tube, the reduction gearing, pinions and such extremely important items were made of alloy steels and had proved themselves to be very reliable. Technologists in the industry regarded it as retrograde to contemplate a return to the old mild steel. As to the X-ray examination of castings, it must be recognised that the X-ray apparatus was a useful tool for investigating important parts, but he predicted that extended use of X-rays for examining steel castings would inevitably result in bringing home to the Admiralty and others the truth that castings were not as good as forgings. Even if everything were subordinated to simplicity of design in a casting, one needed all that technology could do to produce a perfect piece of steel. If the drawing-office designed curious shapes for castings it was a physical impossibility to produce the castings free from internal defects, and X-ray examination would disclose their existence. As to the author's statement that he had not found a stainless steel which was satisfactory in contact with sea water, he was anxious to know if adequate trial had been given to the chromium-nickel steels as well as the chromium steels. Criticising a statement in the paper that "Staybrite" steel had been found unsuccessful for the jackets of submarine engines, he said that the use of "Staybrite" for that purpose was perfectly satisfactory until the introduction of a modified form of fabrication which involved excessive local cold work, and that proper steps were not taken, after the cold working, to treat the metal and prevent stress cracking.

Mr. Richard Allen took exception to a reference in the paper to impulse blading shrouding having worked loose owing "to excessive vibration or defective workmanship in riveting the blades to the shrouding," and said that in his experience the trouble was not due to defective workmanship, but rather to the material used and the design. In his experience, the steels used for turbine blades were not sufficiently ductile to ensure satisfactory riveting of the blade to the shrouding, and the best blades he had found were of stainless iron, which was more ductile than stainless steel, would withstand the vibrations better and was easier to rivet. Whilst realising that steel castings for naval purposes were sometimes difficult to produce, he regretted to say that no progress had been made with regard to steel casting production during the last five years in this country. Finally, he paid a tribute to Perlit cast iron, with which satisfactory results were obtained with castings of greatly varying sections, and he regarded it as one of the great advances made since the war.

Mr. Harold E. Yarrow suggested that the boiler brickwork difficulties in warhips were partly attributable to the variation in conditions. Whereas a warship steamed at full power for a day or so, and then perhaps did nothing for a few days so that there were continual changes in temperature, a merchant vessel steamed regularly for long periods and at a lower rating. Further, in the second case, the brickwork of the boiler could be cooled by leading air round it before it passed to the furnace for combustion. Discussing heat-resisting steels, he asked if the author had had experience of any which could be made into superheater tubes and which at the same time could be expanded and bell-mouthed.

Engineer-Captain W. Onyon, whilst agreeing that the elimination of zinc from a condenser tube was a step in the right direction, pointed out that there was nothing wrong with the Admiralty mixture—70 per cent. copper, 29 per cent. zinc and 1 per cent. tin—if it were properly mixed, and if proper care were taken also in the manufacture of the tubes. Some years ago, when certain tubes had de-zincified, it had been urged that a metal containing zinc should not be used for condenser tubes, and some people in Birmingham had tried to make tubes composed of copper and nickel. Melloid tubes had since been put into H.M.S. "Cornwall"—a cruiser of the "Kent" class—and in three years only one of them had failed. He asked whether tubes of other materials mentioned in the paper had been fitted to the main condensers of his Majesty's ships, or only to the auxiliary condensers. The Admiralty white metal was the best material one could get for condenser tubes, if it were properly made, and it was, perhaps, due to lack of proper methods of temperature control that its use had been abandoned.

Engineer-Captain H. B. Tostevin, referring to the boiler brickwork, said that air-heating was not adopted in the Service, not because the Admiralty did not believe in it, but because practical considerations had defeated the fitting of air heaters, except in one or two special cases. He asked whether Captain Hope Harrison considered that, if air heating were adopted, more serious trouble was to be expected with the brickwork. With regard to heat-resisting steels for superheater tube supports, he said that he had read of the use of mild steel treated with aluminium, and it would be interesting to know the general opinion at the Admiralty with regard to that material. The importance of the condenser tube problem was emphasised by the large number of materials that were being tried. Of the twelve materials mentioned in the paper, it was stated that only three were satisfactory from the point of view of resistance to corrosion, up to the present, and he asked whether the failure of the other materials was attributable not so much to the materials themselves, but rather to the fact that the technique of production of the tubes in those materials was not yet up to the standard reached with other materials. The use of uncooled valves in heavy oil engines was an important consideration, because if valves had to be cooled they must be provided with flexible connections, which must have comparatively small passages, and they were liable to become choked. Discussing aluminium, he said that it seemed that the "Y" alloy was still the only satisfactory aluminium alloy for comparatively large pistons—of 20in. diameter, or more—and he asked if even better results were likely to be obtained regularly in the future with it.

Mr. W. Hamilton Martin suggested that creep tests of heat-resisting steels should be conducted under temperatures and in atmospheres similar to those in which the materials worked in practice. He also mentioned a heat-resisting steel, which could be worked and bell-mouthed as well as ordinary steel. He had seen parts of tubes of this material bell-mouthed to 65 per cent. of their diameter and doubled up and squeezed end-wise without cracking. At a temperature of 1100 deg. Cent. the material was about 130 per cent. stronger than mild steel at that temperature and the yield point was 100 per cent. higher.

Engineer-Rear-Admiral Rundle said that experiments on aluminium-brass condenser tubes had shown that the protective aluminium oxide film which formed on the surface healed itself if it were broken, and that there was reason to hope that the material would be valuable in service.

Engineer-Captain Hope Harrison, replying to some of the points raised in the discussion, agreed with Mr. Allen that defective shrouding was possibly due to defective design. He had not meant to state positively that it was necessarily due to bad workmanship. He disagreed with the suggestion that progress had not been made with regard to steel castings during the last five years. In the investigations of steel castings, referred to in the paper, castings which had given trouble had been cut up and investigated thoroughly in order to find the reasons for failure, consideration being given also to the design and the moulding. With regard to heat-resisting steels for superheater tubes, he said that the Admiralty had had its eye on such steels, but had not yet any information of value based on actual experience. Replying to Engineer-Captain Onyon's remarks with regard to condenser tubes, he said that H.M.S. "Queen Elizabeth" had never had condenser tube trouble from the day she went out to the Dardenelles until the present time. A number of the condenser tube materials mentioned in the paper had been used both in the main and in the auxiliary condensers. As to boiler brickwork, and the use of pre-heated air, he said that higher furnace temperatures could be expected when pre-heated air was used, even assuming that the air was heated by passing it round the brickwork. Steel treated with aluminium had been used for certain purposes by the Admiralty, but it would not be fair to quote the results obtained, because it was used for a purpose for which the manufacturers had doubted its success. He agreed that early failures of condenser tubes made of experimental alloys ought not to be regarded as positive evidence that a material was not suitable. In some cases it had taken a year or more to obtain tubes which were considered by the Admiralty inspectors to be satisfactory in these experimental alloys. As to the "Y" aluminium alloy, the results of physical tests on that material had improved steadily during the last eighteen months, and he believed that in a short time it would be found that specimens which did not give results of over 40 per cent. elongation and 20 tons ultimate tensile strength would be exceptional.

On Thursday, April 10th, at the Morning Session, two papers, one by Dr. Meijer and the other by Mr. W. J. Belsey were discussed together. An abstract of Dr. Meijer's paper which describes the service results of the Holland-America liner "Statendam" is given on page 432. With Mr. Belsey's paper, which deals with the performance of two vessels—the "Viceroy of India" and the "Brunswick," which are fitted with electric transmission gear, we hope to deal in a future issue.

Performances of Vessels.

Mr. J. Johnson, after commenting that Mr. Belsey's paper was opportune in view of the fact that interest in the electric drive had quickened appreciably in recent years, said that as the commercial advantages of high-pressure steam were more widely recognised, expert discrimination was becoming necessary to determine its most suitable application. The high efficiency maintained by the water-tube boilers in the "Viceroy of India" and other vessels, however, should allay any doubts hitherto entertained on that score. The use of high-pressure high-temperature steam again raised questions as to the reliability of astern turbines and the adequacy of their power for manœuvring purposes. The conditions, undoubtedly, appeared somewhat more onerous than those which obtained in earlier steam practice, but, given suitable design, there seemed to be no grounds for apprehension. Nevertheless, the conditions attending the manœuvring and reversal of large steamers were, on occasion, very exacting, and there was no room for special tenderness when handling engines under urgent telegraph orders. The graph in the Appendix showed that, with the vessel travelling ahead at full speed, reversal of the propellers was effected in 30 seconds, that they were moving astern at 20 revolutions per minute 35 seconds after ahead steam was shut off, and that, in order to secure that, seven operations were involved. It was also shown that the ship was stopped in 2 minutes 10 seconds. As compared with this performance, a similar steamship fitted with astern turbines was brought to rest in 5 minutes, the operations required being the shutting of the ahead steam valve and the opening of the astern valve. That, however, could be improved upon in emergency by quicker operation of the valves, which would involve no risk to the machinery. The shipowner, naturally, was interested in the possibilities of turbo-electric drive, and must, perforce, closely examine its claims. Absence of noise and vibration, as Mr. Belsey had observed, was an important consideration in passenger ships. Passengers would travel on any vessel in which there was no observable discomfort arising from the mode of propulsion, and that was certainly true of a modern geared drive. Several ships had been commissioned during the last two or three years closely resembling in general proportions the "Viceroy of India," and for purposes of comparison he gave the following figures illustrating the performance of several ships on the "measured mile":—

	"Viceroy of India."	"Empress of Australia."	"Empress of Canada."	"Duchess of York."
Length (B.P.)	585	580	625	580
Breadth	78	75	17·5	75·25
Draught	23ft. 9½in.	26ft. 5½in.	24ft. 9in.	23ft. 8½in.
Displacement	19,050	22,350	22,220	20,590
Block coefficient (at trial draught)	·63	·681	·649	·70
Speed on mile	19·35	19·50	21·85	18·50
S.H.P. on mile	17,000	20,000	26,000	15,450
$D^{\frac{2}{3}} V^3$ / S.H.P.	305	293	316	307

These figures disposed of the suggestion that there was any substantial inaccuracy in the recording of power, for it would be seen that the Admiralty coefficients of the three vessels quoted compared very favourably with the "Viceroy of India," although she has a block coefficient of ·63—a much finer form than the other vessels.

The "Viceroy of India's" log abstract showed wide variations of performance, which made a close analysis of individual runs rather difficult. In these circumstances, the only basis practicable for making a comparison with other vessels was the complete voyage. The following table is of interest:—

Averages for Complete Voyage—Outward and Homeward.

Ship.	Speed.	Displacement.	$\frac{D^{\frac{2}{3}} V^3}{S.H.P.}$	$\frac{D^{\frac{2}{3}} V^3}{\text{Tons per day (propn.)}}$	Fuel per S.H.P./hour (propn.)
"Viceroy of India"	16·33	20,170	296	39,325	·702
"Empress of Australia"	19·25	22,500	285	40,850	·65
"Duchess of York"	18·20	21,030	284	44,300	·60

The Admiralty coefficient recorded for the "Viceroy of India" against a speed of 16·33 knots was 296. The corresponding coefficient on trial was 350, so that there appeared to be an increase in resistance of the order of 15 per cent. as compared with the "measured mile" conditions. That, of course, was a very high figure for a voyage from London to Bombay and back again, but if it was quite dependable, then the corresponding fuel rate per horse-power was ·702 lb. of oil for propelling purposes. He scarcely had the temerity to suggest that the horse-power might be inaccurate, but it was really not of vital importance, as comparisons could be restricted to the fuel coefficients. Although the "Empress of Australia," which had a low-pressure steam installation, had registered a coefficient slightly in excess of 4 per cent. better on a 3½ per cent. lower Admiralty coefficient, the "Duchess of York" showed a fuel coefficient 11 per cent. higher, notwithstanding her Admiralty coefficient being 4 per cent. less. The marked differences in speed and their effect upon coefficients would, of course, be realised. Whether the matter was looked at from the angle of fuel coefficients or the cost of producing power,

the conclusion reached was the same. On a conservative estimate, there would appear to be at least 12 per cent. in favour of the geared drive at full power; that figure was confirmed by trials and service results alike. He added, however, that over a period of nine voyages, including the tempestuous weather during the winter just ended, the "Duchess of York" had registered a fuel coefficient of 42,000 at a speed of 17·82 knots, the Admiralty coefficient being 269, *i.e.*, 17 per cent. reduction on the "measured mile" performance; also, she had made individual Atlantic passages in fair weather on a fuel coefficient of 48,000, although she was driven at a speed of ½ knot in excess of the designed figure. It would be evident, that, when considering the behaviour of the geared drive and turbo-electric drive at reduced powers, the margin of 12 per cent. had to be eliminated before parity was reached.

In view of the claims made for electric transmission at reduced powers, the performance of the "Viceroy of India" seemed disappointing, as, if the condition was examined in which one turbine was operating two motors with one set of auxiliaries shut down, the fuel rate was 0·775 (propelling). The result obtained with geared turbines, on the other hand, at 50 per cent. of the designed power was 0·665 (propelling). The turbo-electric system, as exemplified in the "Viceroy of India," using high-pressure steam and high-efficiency water-tube boilers, actually fell short of the performance of a low-pressure installation, such as the "Empress of Australia." One must, therefore, conclude that the thermal advantages of higher pressure and temperature, feed heating, &c., had been swallowed up by the electrical transmission losses. With regard to consumption, he observed that in a ship of this class 10 per cent. of the steaming fuel might amount to 2000 tons on 200 days' steaming, or, say, in round figures, £5000 per annum. Fuel consumption might be regarded by some as subordinate to other considerations. It should be noted, however, that the higher fuel rate necessitated larger boilers, the heating surface of the "Viceroy of India" boilers being 32,500 square feet for 17,000 S.H.P., as against 30,690 square feet for the "Duchess of Bedford" at 18,000 S.H.P.; that was 12 per cent. greater surface for equal power. Similarly, greater weight of bunkers was required for a given steaming radius. An increase in the weight of machinery and bunkers necessitated an increase in displacement and gross horse-power, or a reduction in deadweight. In large high-speed vessels those were important considerations and had substantial repercussions on first cost and running expenses. In the face of competition such factors comprised the data upon which the choice of propelling machinery had to be made.

With regard to reliability, speaking with a full realisation of the actual faults which experience had shown might occur in astern turbines and mechanical gearing, Mr. Johnson said that he could not find anything inherently objectionable or unsound in them, or any degree of unfitness for the very severe conditions liable to be imposed upon them. His own view was that most mishaps or depreciation incidental to the comparatively slow-speed turbine as used with the geared drive could be overtaken on board ship. It was doubtful whether that could be said of the high-speed turbines used in association with electric drive, a mishap to which would put out of action half the total power. A mishap to one of the three turbines in a geared drive could, of course, be adjusted temporarily without serious loss of power by the removal of a pinion. Turbo-electric propulsion would have to exhibit an overwhelming superiority in terms of reliability and maintenance expenses to warrant the premium which must be faced on account of its inherent disability, as expressed in first cost and fuel consumption, before its adoption could be justified, but there appeared to be no evidence of that superiority.

Mr. Harold E. Yarrow said that the two papers by Mr. Belsey and Dr. Meijer contained most valuable particulars of modern marine engineering practice. The high efficiencies that were being obtained with high-pressure steam installations had resulted in many large liners and other ships being propelled by that type of machinery. The progress in boiler design and construction had largely contributed to the satisfactory results obtained on many liners operating with high-pressure steam. For instance, the efficiency obtained on the boiler trials of the "Statendam" given in Dr. Meijer's paper was what would be expected in a modern boiler installation. With permission of the P. and O. Steam Navigation Company, through its Superintendent Engineer, Mr. R. T. Clarke, he gave the following information as to the boilers of the "Viceroy of India," as compared with the Yarrow boiler of the two new P. and O. liners.

In the "Viceroy of India" there are six boilers of a total generating surface of 32,500 square feet, occupying space of 3950 square feet, which is equivalent to about 45 lb. of steam evaporated per square foot of floor area. In the new ships there are four boilers of a total generating surface of 50,000 square feet, occupying a space of 3650 square feet, equivalent, at the same rating as the boilers of the "Viceroy of India," to about 76 lb. of steam evaporated per square foot of floor area, or, to put it in another way, the four large boilers will give an evaporation of about 50 per cent. more than the six smaller boilers and occupy about 10 per cent. less space. In both cases the rating of the boilers corresponded to an efficiency of about 87 per cent.

It had been possible to secure this layout by placing the oil burners on one side of each boiler instead of at the end, as was usual, and arranging the boilers on either side of the centre aisle—two boilers on one side and two on the other. A model showing an installation of six boilers, equivalent to 36,000 S.H.P., illustrated this arrangement. This layout enabled a considerable saving in length to be secured, as no firing space was necessary at the ends of the boilers. Side firing was also necessary for long boilers, as the distribution of heat was uniform throughout the length, whereas, if a long boiler were fired at one end, the end furthest from the burners would not be doing its share of the work. It would be observed from the model that this layout of boilers, air heaters and uptakes lent itself to good deck accommodation in way of the boiler rooms. Where the boilers were fired at the end, as in the case of the boilers of the "Viceroy of India," or at the side, as in the case of the boilers of the two new P. and O. ships, all the steam and water drums were placed fore and aft, which was, of course, most desirable, especially when the ship was rolling or for any reason had a list. These large boilers could be constructed with forged drums with closed-in ends, so that there was an entire absence of riveted and bolted joints, which was all the more important as the steam pressures increased.

Another point of some interest with regard to the boiler arrangement of the two new P. and O. liners was that it had, in many cases in the past, been customary to fit one or two Scotch boilers as well as water-tube boilers, the former operating at a lower pressure and being used in port and for other purposes. Mr. Clarke, however, had decided to do away with the Scotch boilers in these new ships and to replace them by two small high-pressure Yarrow boilers, which could be used for harbour purposes, &c., so that the entire installation would consist of water-tube boilers all of the same high pressure and temperature.

Mr. R. T. Clarke (Superintending Engineer, P. and O. Line), said that when planning out the machinery and boilers of the "Viceroy of India," built by Messrs. Alexander Stephen and Sons, for the P. and O. Company, all points and their relation to one another were very carefully weighed in order that fuel consumption, main and other loads, weight, space, noise, vibration, supervision, number of working parts, maintenance costs, and the consumption of stores should be less, if possible, than in the previous best ship afloat for equal power output. The electric drive with high-pressure water-tube boilers and turbo-generators for auxiliary purposes, appeared to meet these requirements more satisfactorily as compared with other types of machinery, and so far the venture had been very encouraging. The ship had now completed 82,500 miles without any sign of any defective steam joints or trouble of any kind; the manœuvring qualities, which were good, had exceeded expectations, and the simple and systematic lay-out of the machinery and perfect ventilation everywhere, to which this type of machinery lent itself, was much valued by the engineering *personnel*.

The Yarrow water-tube boilers had shown an economy beyond that attributable to their 85 per cent. voyage efficiency, in the way of getting rid of heat transmission between boiler-rooms and passenger accommodation, the reduction of radiation surfaces and the use of air heaters having reduced insulation costs and upkeep; and a further saving was noticeable in the cost of making good small oil leaks in bunkers which usually showed up from time to time owing to straining of superstructure in boiler rooms in bad weather. The boilers needed no riveted attachments to bunker plating to support them, and there was less structural straining generally owing to their lighter weight and flexibility as compared with cylindrical boiler installations. With reference to Mr. Belsey's remark regarding a wattless current flowing through the system in the event of the propeller being stopped from outside, that happened on one occasion in the "Viceroy of India," when in the Suez Canal. The motors were seen by the engineer on watch to break out of step, owing to the propeller striking the bank. No harm, however, was done to the propeller or machinery. Had the ship been propelled by a through shaft drive, possibly the propeller would have cut through the side of the bank unnoticed, and nothing would have been known of the occurrence until the damaged blades were sighted in dry dock.

With regard to comparative fuel consumptions between electric and geared drives, experience had proved that, for the same steam and vacuum conditions, the efficiencies on a turbine brake horse-power basis were about the same, the reduced quantity of lubricating oil used—less than 3 gallons per day—and various other smaller savings more than outweighing the cost of the power consumed for excitation and ventilating generators and motors. The turbines of the "Viceroy of India" had each eighteen rows of robust blading, with ample clearance between nozzles and blades, and there seemed to be no saving worth considering in having three turbines with about 300 rows of very fine clearanced blading to each shaft, as was usual with the straight drive, when eighteen rows of blading would do the same work economically. With the electric drive there was so little cooling water needed that it was a simple matter to keep the tank tops in the machinery compartments perfectly dry and in good preservation. He saw no reason, barring accidents, why a ship with this type of machinery should not retain her high efficiency for life or should ever have to lay up for repairs, provided a spare turbine rotor was carried. It would occupy little space and could be placed in position without delay at any port in the event of the running turbine stripping, passing too much steam, or vibrating for want of re-balancing. Finally, he mentioned that, by installing all high-pressure water-tube boilers in the two new turbo-electric ships being built for the P. and O. Company by Vickers-Armstrongs, it had been possible comfortably to accommodate the boilers and machinery of 28,000 S.H.P. in a length of 110ft., the motors occupying the lesser freight-earning space at the after part of the tunnel.

Mr. W. Nithsdale said that it was interesting to reflect that the working pressure of the plant described by Dr. Meijer was becoming almost commonplace in the mercantile marine. During the last three years water-tube boiler installations totalling over a million square feet of heating surface, to work at 400 lb. per square inch pressure or more, had been ordered for merchant vessels. Referring to the boilers on the "Statendam," he said that it was stated in the paper that the boiler efficiency was assumed to be 87 per cent., and a trial to corroborate this was made on November 21st–22nd, when the ship was quiet. The trial efficiency was then worked out to two decimal places, while the fuel consumption was accepted as a round figure in tons, although 1 ton was equivalent to about 0·7 per cent. efficiency. A table in the paper revealed that, whereas the average funnel temperature was 281 deg. Fah., the temperature of the gases leaving the air heaters averaged 321 deg. Fah. The author had referred to stokehold air on its way up to the annular space between outer and inner funnel, so that apparently there was no return of the heat loss in the uptakes represented by the 40 deg. Fah. drop in the gases, whose leaving temperature seemed really to be 321 deg. Fah. It was also explained in the paper that only the backs of the boilers were air jacketed, while the heat radiated from the boiler fronts, sides and tops, warmed the surrounding atmospheric air, which was for the greater part trapped by the forced draught fans, leading to an average air temperature of 98 deg. Fah. entering the fans. The fans draw air from the boiler tops, but even so, surely 98 deg. Fah. was a high stokehold air temperature for a modern ship in the middle of the Atlantic in mid-November, and it appeared that the radiation from the boilers must be considerable. He asked for fuller particulars of the turbine installation of the vessel, where it was noted that the condenser losses were confined to 63 per cent. of the steam production. Doubtless, it was largely to this feature that the low consumption was due, and, indeed, it was in the machinery and at the condensing end of steam plant where the greater economies were to be found. Modern boilers had reached a high level of efficiency for up-to-date conditions, and it was now on the engine-room that efforts should be concentrated for further improvements. The figure of 0·618 lb. per S.H.P. seemed to be that of the best day during the voyage, when no additional evaporators were in use. On two other days the consumption was over 0·65 lb. per S.H.P., but he could not find in the paper a figure for the round voyage. He asked if any upkeep costs had yet been returned in respect of this installation. The radiant surface of the boilers seemed small and the furnace of low height, and he was interested as to how the brickwork was standing. The raising of the forced draught fan pressure had a bad effect on the boiler efficiency, and he asked whether any overload could be carried. Again, he asked for information as to how the drums were placed. The tendency in large passenger liners was for water-tube boilers to increase in size, and it would appear most desirable that the drums should be placed fore and aft to secure a more even water level when the vessel was rolling and prevent damage to the boilers. Further, the placing of the drums fore and aft enabled a good efficiency to be maintained, which was not easy if there were considerable surging of water in the drums.

Mr. W. J. Willett Bruce said that it seemed to him that the severe objections to water-tube boilers for marine work which had been raised by various engineers, who had been responsible for effecting improvements in liners from time to time, had been more or less removed, and that the general feeling was one of confidence in the application of the water-tube boiler in the mercantile marine. With regard to the life of the tubes, he said that he had made very exhaustive inquiries, and that one very eminent authority had expressed the view, after having had an extensive experience of water-tube boilers, that if we could get seven, or at the outside ten, years' life in an installation of water-tube boilers without having to renew the tubes we should be doing very well. That was very disconcerting, because the old tank boilers could be run practically to the termination of the useful life of a ship, and he had felt unhappy about having to report to his directors that they would have to spend some thousands of pounds on the renewal of tubes of water-tube boilers after seven or eight years' life. His experience with a large installation with which

he was associated, however, was that six months ago the tubes were in as good a condition as when they were installed several years previously, and if the same care that had been exercised so far were exercised in the future—distilled water was used entirely—there was no reason why the tubes should not last for twenty years, if not more. Another important consideration in connection with high-pressure steam installations was that it was essential to have an absolutely tight condenser, and if that were assured, there should be no fears as to the maintenance of water-tube boilers. With regard to the results on the "Statendam," he was satisfied that Dr. Meijer had been very frank and, indeed, that he had somewhat under-estimated. He felt sure that in the future, as the *personnel* became more acquainted with the details of the installation, even better results would be attained, and that the consumption would possibly be reduced.

Discussing the electric drive, he agreed that there was a great deal to be said in its favour, but whether the same results as had been mentioned by Mr. Belsey would be obtained in a big installation of 120,000 or 130,000 H.P. was a moot point.

Mr. S. S. Cook, in a criticism of the electrical system of propulsion as compared with the geared turbine system, said that the conversion of heat energy into mechanical energy was effected in the turbine. The electrical system superposed a further conversion into electrical energy and a re-conversion into mechanical energy at the proper shaft, and clearly that additional conversion and re-conversion, with the additional plant and additional operations it entailed, required justification. Electric transmission on land achieved the conveyance of power economically to a distance or distribution of power to a variety of units from a central producing plant. Neither of those conditions were required in ship propulsion, however, because the power was utilised where it was produced, and the power-producing plant could be divided conveniently into as many units as there were propeller shafts. Therefore, neither of those grounds could properly be brought in as justification for the double conversion. In the geared turbine system the speed reduction from turbine to propeller shaft was effected by toothed gearing, having an efficiency of not less than 98 per cent., and for large powers, with large pinions, probably 99 per cent. In an electric propulsion system the speed reduction was effected in the electric transmission, the current generated in high-speed alternators being used to supply low-speed motors on the propeller shafts. The electric system must, therefore, be considered on its merits as an alternative means of speed reducing, and could only justify its adoption if it effected the speed reduction better than mechanical gearing as regards economy, reliability or flexibility. The fuel consumptions given in the paper did not represent a high degree of economy in comparison with up-to-date geared turbine ships, as exemplified in the "Duchess" class steamers of the C.P.S. The maintenance of economy at low speeds which was claimed to be obtained by using a single turbo-generator to serve both propelling motors was not apparent from the fuel consumption for the parts of the voyage which were made under those conditions, although in the attempt to achieve that economy at reduced speeds by subdivision, turbines and alternators appeared to have been provided of a total capacity 36 per cent. in excess of the service power. Where maintenance of efficiency at reduced powers was required it could easily be obtained in a geared turbine drive. In an installation under construction for a large Atlantic liner, in which the requirements were a service power 80 per cent. of the maximum, and occasional runs at half power, turbines had been provided which gave a steam consumption rate at half power equal to that at the maximum. The auxiliary consumption could be kept down by having the circulating pumps, &c., in two units for each condenser, only one of which would be run with the ship at half power.

Summing up the position as to economy, Mr. Cook said that, as shown by the paper, no gain was found with the electric installation; indeed, it was rather the reverse, as might have been expected from the additional losses of transmission, and the claim for economy at reduced powers was not substantiated by the results given. Therefore, the electric drive must show superiority in respect of reliability and flexibility, if it were to have any real claim for preference, but little reference was made to them in the paper. On the other hand, mechanical gearing had already proved its general reliability. There had been continuous improvement in the technique of gear cutting, and the latest gears were both quiet and free from vibration. The turbines associated with the geared drive were small units, and in the event of derangement they were easily repaired. With three turbines per shaft the failure of one of them left still a large percentage of power, from 85 to 90 per cent. of the maximum available to drive the ship. On the other hand, the degree of reliability of the electric transmission was as yet unproved. The turbines had high peripheral speeds and stresses, and many cases of serious trouble arising from that cause had been reported from the States. Failure of one turbine or generator left only one half the maximum power available to drive the ship. Apparently, that was recognised in the case of the "Viceroy of India," because the maximum capacity of each turbo-alternator had been increased by about 36 per cent.; but, even so, the power available in the event of derangement of one turbine was less than 70 per cent. of the total service power. Discussing flexibility, he pointed out that the number of operations to be carried out for astern going was considerably greater with the electric drive than with the geared turbine drive. When running with a single alternator, manœuvring possibilities were somewhat restricted by the fixed ratio between turbine and propeller, which made it impossible to go ahead on one shaft and astern on the other at different speeds.

Engineer Rear-Admiral W. M. Whayman said that Dr. Meijer's paper confirmed that the use of higher steam pressures was quite a safe and reliable proposition, and that the advantages in fuel economy resulting from the use of higher steam pressures had been realised on service. The results given for the voyage between Rotterdam and New York were of particular interest, and it was of interest also to note that the excellent boiler efficiency on the selected date had been obtained at a rate of steaming of nearly 6 lb. of steam per square foot of boiler heating surface A further analysis of Dr. Meijer's figures indicated that of the total of 87·3 per cent. of the heat utilised from the fuel, 76·8 per cent. was absorbed by the boiler and 10·5 per cent. by the superheater. He concurred with the reasons given by Dr. Meijer for the high boiler efficiency. It was possible, however, that even slightly better overall boiler efficiency might have been obtained if the closed stokehold system of draught had been adopted instead of the system fitted with closed air trunks from the fan delivery to the air heater inlets. It had been pointed out that a great part of the heat radiated from the boiler was trapped by the fan inlet. With the closed stokehold system of draught, practically the whole of the heat radiated from the boilers was used again in the furnace, with the exception of the small amount absorbed by the boundaries of the boiler room compartment. The closed stokehold system ensured more easily a balanced system of draught and no leakage from the boiler into the room in which the *personnel* were working.

Discussing Mr. Belsey's paper, Admiral Whayman said that a very good case was made out for electric transmission in many cases, and some of the performances quoted in the paper for main engines were good, but if the figures for all purposes were compared it would be found that the fuel consumption with the steam turbine propelling machinery did not compare favourably with similar figures from a large number of other ships which were using mechanical transmission of power to the propeller and various methods of driving auxiliaries. It was quite true, as Mr. Belsey had stated, that the high efficiency of the boiler installation had considerable bearing on the good results if considered solely in relation to the performance of this particular plant, but if the comparative merits of the overall machinery performance with turbine electric transmission were being considered as compared with mechanical transmission, then the boiler must be regarded as an impartial assistant, because equally high efficiency results by the boiler could be applied to either method of power transmission.

Sir John Biles said that an engineer had insinuated some five years ago that the use of steam was dead, but the papers had served to remove any suspicion that there was not life in steam still. With regard to electric transmission, he recalled that about twenty years ago he had thought that a method of transmission by means of a dynamo and motor was a good one, and in association with the late Mr. Henry Mavor he had produced some plans and had sent them to the Admiralty, but the Admiralty had replied that they were fully aware of all that was possible with electricity, and that they did not propose to adopt it. A little later Sir Charles Parsons' geared turbine was introduced. At the time, he, Sir John, was proposing electric transmission, he had realised that the loss was 12 per cent. between the dynamo and the motor and the transmission. The Parsons gear sacrificed 2 per cent., so that there was still a difference of 10 per cent., and his enthusiasm for electric transmission had faded on account of that. In Mr. Belsey's paper he had noted that when the turbo-electric drive was running at 14,500, there was a figure of about 0·7 lb. per S.H.P., and on the "Statendam" at 21,000, the figure was 0·636. Those were directly comparable figures, and again there was apparent the 10 per cent. which caused him to loose his enthusiasm for electric transmission twenty years ago.

Engineer-Captain H. B. Tostevin, after congratulating Dr. Meijer and the designers of the "Statendam" on the very fine results obtained, asked if the temperature of 120 deg. Fah. in the open feed water tank was considered to be sufficiently high, because that was the place where the air would be released from the feed water, and there was no air release in the further part of the circuit. Referring to the "Viceroy of India," he said that for the service use of that vessel there was no doubt that the turbo-electric drive had a particular advantage. The great bogie of the turbo-electric drive, of course, was the trouble that might be expected as the result of having cables carrying very large currents in the atmosphere of an engine-room at sea, but apparently that matter had been fairly well considered in the present case, judging by the rigid tests and specifications with which the electric cables had to comply. Granted that one could ensure efficiency in that respect, one could not very well doubt the reliability of such a system, having in view the very great experience obtained on shore with high-power electrical installations. With regard to gears, whilst agreeing with Mr. Cook that the technique of gearing had undoubtedly improved, he did not think it could be said truthfully that a completely quiet gear had been evolved. Comparing the application of turbo-electric propulsion in the mercantile marine and in warships, he pointed out that a merchant ship had not to cater for economy in operation over a range of powers from about one-tenth to full power. The maintenance of economy in warships was effected by having one or two cruising stages in the high-pressure turbine of the installation. It might be said that what could be done with a turbine in a geared installation, could be done with a turbine in an electric drive installation. But could it? There were different nozzle groups controlled by different valves on the different stages of the turbine. With electric propulsion the regulation of the turbine was effected not by opening nozzle groups at different stages, but under the control of a governor which was operated from the main switchboard. He asked if it would be possible to arrange a speed governor which could control different groups of nozzle valves at different stages of the turbines, and so arranged that it must also control the turbine speed when any particular nozzle group was being used. That seemed to be something of a Chinese puzzle, and it helped to explain why geared installations with the cruising turbines gave promise of greater efficiency over a larger range than had ever been put forward for turbo-electric propulsion.

Mr. A. C. Hardie said that far-seeing engineers agreed that the electric ship had a definite future. The electric ship was initially more costly, and the fuel saving effected would probably not be greater than with a direct turbine-driven vessel. Turbo-electricity, however, was unquestionably proving itself suitable for passenger liners by reason of its extreme flexibility and manœuvrability. That was shown by the particulars given in Mr. Belsey's paper, which showed that on only two "logs" of the outward voyage and three "logs" of the homeward voyage was it necessary to use the full turbo-alternator output. The fact that a ship could perform the greater part of her voyage with half the propelling machinery shut down, meant that the life of that machinery would be greatly lengthened, and that repair bills would be correspondingly cut down. The fact that large refrigerated chambers were installed might have led to electric drive in some electric ships. In cases of ships with high auxiliary electric loads, it did not seem out of place to suggest that the Diesel electric drive had a great deal to recommend it. Indeed, Mr. Belsey himself appeared to support that view when he had said that the Diesel-electric drive would find its application in what might be termed "double-purpose vessels," in which the auxiliary load was a high percentage of the propelling load—for example, in such vessels as fruit and meat carriers. On the other hand, we had to face from the Diesel point of view the disagreeable fact that two large fruit-carrying ships being built in this country were turbo-electric, and that at Belfast a fruit-carrying ship with refrigerated space was in process of conversion from Diesel-electric to turbo-electric. Perhaps in his heart of hearts Mr. Belsey would be inclined to consider that Diesel-electric propulsion would be the more ideal form for these vessels. Mr. Belsey had suggested that Diesel-electric drive was particularly useful for tow boats. Those who knew New York Harbour would realise how true that remark was, and what splendid progress had been made with the Diesel-electrification of New York's Harbour fleet. If the suggestion were made that a tow boat was nothing but a shunting engine and a ferry was nothing but a tramcar, each of which happened to float in the course of their duties, then Mr. Belsey's suggestion seemed to have all the more force. He suggested that such development depended upon the production of a reliable high-speed Diesel engine. There were many who would suggest that the high-speed Diesel engine was fully reliable for the type of vessels that Mr. Belsey suggested, and, to go one step further, if we were to borrow at all from aero-engine practice, we had a high-speed Diesel of opposed piston type, which would appear to be adaptable, with perhaps some modifications, to the driving of electric generators in such small ships as, for example, cross-Channel vessels. This engine had the almost phenomenal weight of 2·8 lb. of a horse-power. It would be interesting to have Mr. Belsey's views on the possibility of the application of such an engine to generator sets.

Mr. Constable, of the Admiralty, pointed out that the electric drive was not a panacea for all the difficulties of marine engineering, but he believed it had its proper place, and that further experience would serve to fit it into the particular spheres in which it would be useful. The problem was one of economics rather than of engineering. It had been proved beyond doubt that an electric transmission system was reliable in an installation of any size, but the shipowner would not be enthusiastic about the most wonderful engineering scheme if he did not see in it

a prospect of increased dividends. The more that information as to actual performances, of the kind given in Mr. Belsey's paper, was made public, the sooner would the shipowner realise that there was something in the electric drive which deserved his attention. The slow progress of the Diesel-electric drive, in this country especially, he believed to be due largely to the fashion of installing large slow-speed, direct-drive, Diesel engines, but he doubted that that fashion would be permanent. Should the cost of Diesel oil advance materially in the near future, the owners of the ships might find difficulty in running them profitably. The Diesel-electric drive was also rather handicapped by weight and first cost, and the actual cost of running, at the current prices of Diesel oil, was very little different from the cost of running a turbo-electric drive, using boiler oil. That explained to some extent the relatively slow expansion of its use. Should a reliable high-speed Diesel engine, of a speed of 1000 r.p.m. or over, be developed—and much work was being done on such designs—the Diesel-electric drive would be given a great impetus, and might even be applicable to very high powers, but there would still be the same dependence on the relatively high-priced Diesel oil. He believed, however, that the turbo-electric drive would definitely be found to be more suitable for the larger-powered vessels. It had been proved at powers of over 200,000 H.P. in the United States aircraft carriers. The larger was the electrical apparatus, the more reliable it became. It was more robust and easier to insulate.

The installation in the "Viceroy of India" appeared at first sight to be on somewhat extravagant lines, but the particular conditions of schedule running justified it, and the duplication of the generating plant gave a very high degree of reliability. The necessity for providing cross-connections to enable one generator to supply both motors in this ship did, however, complicate the switchgear and control arrangements. The simplicity of guarding against any serious effect of a fault on the electrical system, and the ease with which dangerous overloads were automatically prevented in an installation of this kind, were very attractive features. The high overall efficiency of transmission actually obtained disposed of the usual criticism of the electric drive as being hopelessly inefficient as compared with gearing, but, of course the final criterion of any drive was the amount of fuel required for a given voyage, and on that basis also a ship of the class of the "Viceroy of India," with the electric drive, need not fear comparison with a similar gear-driven vessel. Comparisons which were made, however, were never exact. There was always some difference in the block coefficient of the ship or the speed of running, and so on, which detracted from the absolute fairness of the comparison.

If a criticism of so satisfactory an installation as that of the "Viceroy of India" might be made, it was in respect of the omission of means to obtain the appreciable improvement in overall economy possible by supplying the ship's auxiliary services from the main shafts when at sea. Various well-known methods of effecting that were available, on the lines of the automatically-controlled house sets in use in some of the large modern power stations. Although some additional auxiliary plant would be required, since separately-driven auxiliary sets up to a considerable proportion of the total capacity would be necessary for use in harbour and at low manœuvring speeds, the gain in overall economy would justify this addition. An increased economy of 3 per cent. could be obtained. The "Brunswick" was an interesting example of the low-powered Diesel electric ship, but it was an open question whether alternating-current transmission would not have been found more suitable in such an installation. The ability to control the ship's manœuvring directly from the bridge, conferred readily by the direct-current system, was a good "talking point," but was of doubtful practical utility in the average case. An advantage of the time-honoured system of control by telegraph and manual operation was the impossibility of obeying all the orders of a nervous pilot, to the great benefit of the machinery and the enhanced safety of the ship.

No large improvement in economy could be expected from any electrical transmission system as compared with the performance of an equally well-designed and carefully installed purely mechanical system, but every case should be considered on its merits, taking all factors into consideration, not excluding the normal schedule running of the ship and the probable prices of fuel at the ports of call. He was fully convinced, however, that in many cases an economy well worth having, in these days of severe competition, would be obtained in cases in which an electric drive was installed, to say nothing of the advantages of smoother running and freedom from trouble and anxiety in adverse weather conditions. There was no doubt in his mind as to the superiority at the present time of a properly designed turbo-electric drive over the geared drive for the projected new fast British Atlantic liners. Reasons for that were that it would be as economical as anything that could be installed, and there would be certainty of success. Another reason was that the scheme was less experimental than any other scheme which could be installed at present.

Dr. Meijer, replying to Mr. Nithsdale, said that the explanation of the difference between the average temperature of the flue gases in the funnel and the gases leaving the air heater was that the temperature reading above the air heater was very local; the thermometer was very close above the air heater, at a point where the temperature of the air was highest, and it was apparent that the temperature of the flue gases at that spot would be higher than the average. He admitted that the temperature at the boiler tops was rather high in the "Statendam," the explanation being that the space there was very congested. In addition to the boilers and air heaters, the steam pipes and fuel pipes ran through this space, and it was difficult to ventilate. With regard to fuel consumption, it was true that the figure of 0·618 lb. per S.H.P. was the best for the voyage, but at the same time it was the figure which could be relied upon as being correct, because on all the other days during the voyage there were conditions which could not be regarded as normal. He would not like to regard the figure of 0·636 as a real average figure for the voyage; it was wiser to analyse the figures for one particular day when the weather conditions were such that the figures obtained were reliable. During the year in which the "Statendam" had been in service no undue costs had been incurred in maintaining the boilers. Three of the ships were running with water-tube boilers. Two of them were working at the normal 215 lb. pressure and had no preheated air, but in the "Statendam" the combustion air was highly preheated, and it was feared at the outset that it might give some trouble, but that had not been the experience. The only trouble during the year had been the bursting of one water pipe. That had burst during the second voyage, but at that time the engineers were not fully conversant with the proper treatment of the boiler water. However, one could not judge after only one year's working. The cost of upkeep during the year had been no higher than on the normal 215-lb. pressure boilers.

The drums were not placed in the fore-and-aft positions, and there had been no difficulty in the proper regulation of the feed water. For the first filling of the boilers on the "Statendam," after cleaning, distilled water was used exclusively. He agreed that tightness of condensers was of the utmost importance, but another important point was to ensure the proper treatment of the boiler feed water. It was not sufficient merely to have distilled water, but the distilled water had to be treated, and special attention had been given to that from the beginning. When the "Statendam" was first operated the boiler water was given the ordinary treatment with soda and lime. When the boilers were opened up for inspection after the first voyage, however, it was found that they were rather rusty on the inside. That had not caused anxiety at the time, but it was realised that in the future that might develop into corrosion. On the second voyage more lime was used than on the first voyage, and, in fact, it was overdone; on that voyage a boiler tube was blown out. That experience, however, had increased their belief in the reliability of the high-pressure boiler, because the tube which had burst had nearly one-eighth of an inch of scale in it. Had they not seen the tube they would not have believed that anything like that thickness could have developed inside the tube of a 400-lb. pressure boiler without bursting the tube. After that the quantity of lime was reduced, and tri-sodium phosphite was substituted for the soda. Since then there had been no trouble at all with the boilers, and the insides were quite clean.

Dr. Meijer went on to say that it was true that, as Mr. Willett-Bruce had suggested, the figures given in the paper were under-estimated. He explained that he had done that in order to be quite sure that there was no danger of over-estimating. He agreed with Engineer Rear-Admiral Whayman that the closed stokehold system might have given better results, and it was being considered very seriously in respect of a ship which it was hoped to build. The temperature of 120 deg. Fah. in the open feed tank could not be regarded as being high enough to get rid of the air in solution. It had been suggested by the builders that the system should be a closed feed system, but he had preferred to retain the system with which the engineers were more acquainted, though he might adopt the closed system on a future occasion. With the open system, however, the air appeared not to have had any ill effect on the boilers.

Mr. Belsey contented himself with a very brief reply to the discussion, and said that he would reply in detail in a written communication. In a reference to the layout of the "Viceroy of India" installation, he said that the space occupied by the turbo-electric drive was exactly the space laid out for the gears, the boilers remaining the same exactly. Discussing the change from Diesel-electric to turbo-electric in a vessel to which reference had been made, he said that the reason was the difference in the costs of Diesel oil and boiler oil in New York; the prices were 14 and 7 dollars per ton respectively.

(To be continued.)

EXTENSIVE harbour improvements, including the construction of a pier costing between 3,000,000 and 4,000,000 dollars, and the addition of several million bushels to the grain storage capacity of the port of Vancouver, are expected to be approved by the Dominion Minister of Marine.

South African Engineering Notes.

Table Bay Dry Dock.

AN agitation is proceeding in the Cape Peninsula for the provision of a new graving dock at Cape Town. For fully 20 years the present graving dock has not been large enough to take the biggest vessels calling regularly at the port, though full advantage has been taken of its existence in so far as its capacity admitted. At the present time the dry dock is too small to take any one of the mail steamers, or the larger vessels of the White Star–Aberdeen Line, the Blue Funnel Line, the large tankers which frequently arrive with heavy cargoes of oil, or the latest Clan Line cargo vessels. Each year the average size of vessels using Table Bay Harbour shows an increase, and as the smaller vessels are sold they are replaced by ships whose breadth in many cases cannot be accommodated in the dry dock. The principal dimensions of the Cape Town graving dock are:—Length, 529ft.; width at entrance, 65·9ft., and of entrance at bottom, 60ft. The depth of water on sill at high water of ordinary spring tides is 24·6ft. The largest mail vessel, the "Carnarvon Castle," has a length of 630·7ft., and is, therefore, over 100ft. longer than the dry dock. In addition to the graving dock there is a repair pontoon with an overall length of 137ft. 6in., which was installed in 1927 at a cost of £30,000, and which is used by trawlers and whalers. A slipway at the head of the Alfred Dock can accommodate vessels up to 600 tons. At Simon's Town, however, distant by sea 40 miles, is a naval dry dock which has a length of 756ft. and is available in cases of emergency by merchantmen. The Prince Edward Dock at Durban, 844 miles distant, is one of the largest in the world designed purely for mercantile purposes. The principal dimensions are: Length, 1150ft. (in case of emergency the length can be increased to 1191ft.); width at entrance, 110ft., and depth on sill at high water of ordinary spring tides, 41ft. There is also a floating dock at Durban with a length of 475ft. and a lifting capacity of 6500 tons. It is obvious, however, that in cases of serious collisions or stranding, it might be impossible to get the damaged vessel round to Simon's Town, and, in any case, the provision of a graving dock at Cape Town, large enough for the biggest mail boat entering the docks, is an absolute necessity, and the case for the port is being strongly placed before the Government. The great point to be emphasised is the fact that before the war the average tonnage of the ships entering Table Bay was between 5000 and 6000 tons. To-day, however, the average tonnage is in the region of 10,000 to 12,000 tons. The average tonnage of ships entering Table Bay has, therefore, been almost doubled during the last 15 years, while the graving dock accommodation is exactly what it was 40 years ago.

Union Air Service.

The company known as Union Airways, Ltd., proposes to appeal to Government for an increased subsidy. When the enterprise started it was subsidised to the extent of £8000 a year for a period of three years, but certain conditions had to be agreed to, the chief one being that by the end of the first year, *i.e.*, August, 1930, the company would be in a position to convert the ordinary mail service into a passenger service. Before the mail service started there was some wavering on the part of the company as to the type of machine to be used, and after the British "Moth" had been decided on, the Fokker Company came near persuading the company to use its machines. The terms offered were so liberal that it was thought that what the Fokker people wanted was not to sell a few planes at a profit, but rather to anticipate the Imperial Airways, whose service from England to South Africa is not expected to be ready until next year. Recently, however, the Union Airways acquired a Fokker machine through the good offices of General Motors (South Africa), Ltd., a branch of the General Motors of the United States of America, a firm which appears resolved to secure a monopoly for the supply not only of motor cars to South Africa, but of commercial motor trucks and so on. It has already got the bulk of the motor car trade and is making much headway with its trucks, &c., thanks to its fine sales organisation. The Union Airways now announces—or, rather, allows newspapers to announce—that to inaugurate a passenger service one Fokker machine is quite inadequate, and that at least three are required, to cost about £5000 each. It is pointed out by the papers dealing with this matter that with the state of the Union finances, Government is not likely to view a further subsidy with favour. It is suggested that the company has a big scheme to open up the entire country, though no hint of it had previously been given and not a single detail is now furnished. Whether the object of the present campaign is to try and get Government to give some indication as to whether it would be prepared to increase the subsidy, or whether the idea is that General Motors should come forward with some helpful suggestion, cannot be said.

Liquid Fuel from South African Coal.

An announcement of the possibility of producing petrol or other liquid fuel from Transvaal and other South African coals, was made by the Minister of Mines and Industry (Mr. A. P. J. Fourie) in replying to a question in the House of Assembly on February 28th. He stated that the Government's present information and knowledge on the subject pointed to Transvaal and other South African coals being suitable for the production of liquid fuels, but no definite statement could be made as a great deal of work remained to be done. There was, however, a prospect of one or other of the great European chemical companies establishing at an early date a factory in the Union for the production of petrol or other liquid fuel from South African coal. The Board of Trade and Industries is watching the technical and economic developments which take place along these lines in all parts of the world, and has given every assistance to those firms or persons who, with the object of establishing such an industry, have sought information on the quality of South African coals and the industrial conditions of the country.

HENNIGSDORF 15,000-KILOWATT PEAK LOAD SUB-STATION

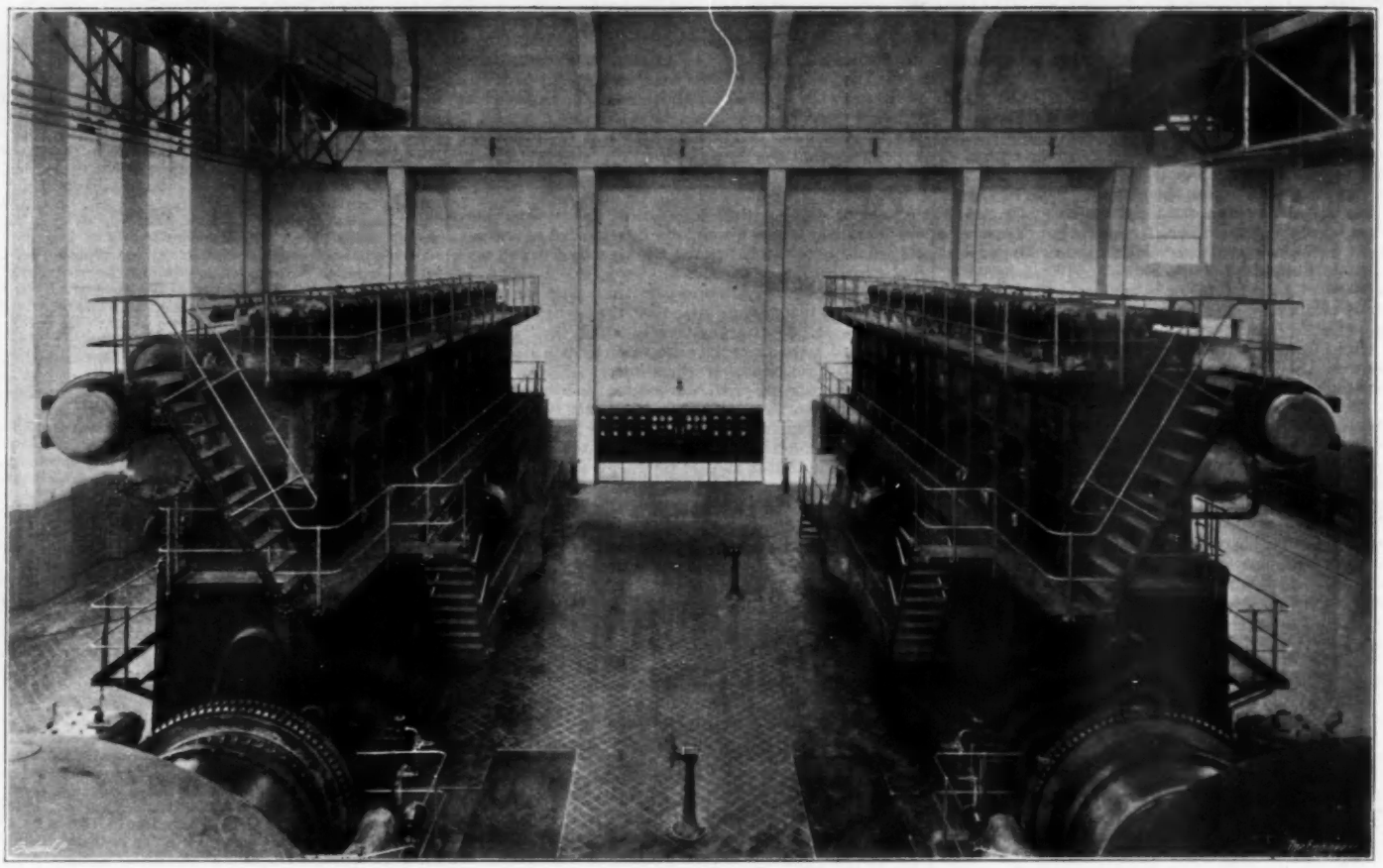

FIG. 1

Large Two-stroke Double-acting Oil Engines for Land and Marine Work.

THE use of high-powered Diesel engines for peak load work was dealt with in a paper read by Mr. M. Gercke, the advisory engineer on power station practice to the Maschinenfabrik Augsburg-Nürnberg A.G., before the Diesel Engine Users Association on May 1st, 1928. In a summary of this paper which appeared in our issue of May 4th, 1928, preliminary particulars with regard to the new 15,000-kW peak load Hennigsdorf station of the Märkischen Elektrizitätswerke A.G., of Berlin, were given. This plant has now been in successful operation since the middle of August last year, and we are now able, through the courtesy of John Le Boutillier, Ltd., the London representatives of the M.A.N. Company, to give some further particulars concerning its equipment and its operation. We also deal briefly, in what follows, with the application of similar engines for ship propulsion, and give details of some of the most recent M.A.N. marine engines.

THE HENNIGSDORF PEAK LOAD STATION.

The installation at the Hennigsdorf peak load sub-station, a view of which is reproduced in Fig. 1, comprises two ten-cylinder M.A.N. two-stroke double-acting engines operating on the airless injection principle. Each engine has a designed output of 11,700 B.H.P. at 214 r.p.m., with cylinders of 600 mm., or 23⅝in., diameter and a stroke of 900 mm. (35 7/16in.). Between the engine and the 7500-kW Siemens-Schuckert generators there are friction couplings of the "Bamag" centrifugal type, which are operated pneumatically and enable the generators to be disconnected from their engines and employed as phase rectifiers.

The station receives its bulk supply from the 110,000-volt high-tension lines of the network which is served by the Finkenheerd super-power station near Frankfurt-on-Oder, and the Trattendorf power station to the south-east of Berlin. Two sets of transformers are installed, which take current from the high-tension 110,000-volt circuit and supply distribution lines at 5000 volts and also at 10,000 volts. Both distribution systems are designed for a normal voltage variation of 5 per cent., so that the maximum voltage may be 5250 or 10,500 volts respectively on the two systems. Each oil engine-driven generator is so arranged that it can be connected alone or both sets together to either system of distribution according to the temporary load circumstances.

We need hardly refer in detail to the design of the engines, since the particular type of engine employed was illustrated and described in our issue of June 28th, 1929. Special attention has been paid to the problem of cooling the liner and the cylinder covers, and for that purpose the liners have been kept as short as possible, so that the combustion space is surrounded by the cylinder cover only. When running at a mean indicated pressure of 90 lb. per square inch the maximum temperature at the hottest part of the liner was only 130 deg. Cent., which is a low figure. The cylinder covers and liners, also the stuffing-boxes on the lower cylinder cover, have been designed so that they are easily dismantled for inspection. The fuel pumps, tachometers, and other controls are conveniently arranged at the front of the engine and are served by a special platform. The fuel pumps for the different cylinders are each timed in the order of cylinder firing, and a governor with a range of 5 per cent. above normal working speed and also hand speed regulation is fitted. A feature of the column design is the provision of through-going tie bolts, which pass from the bed-plate to

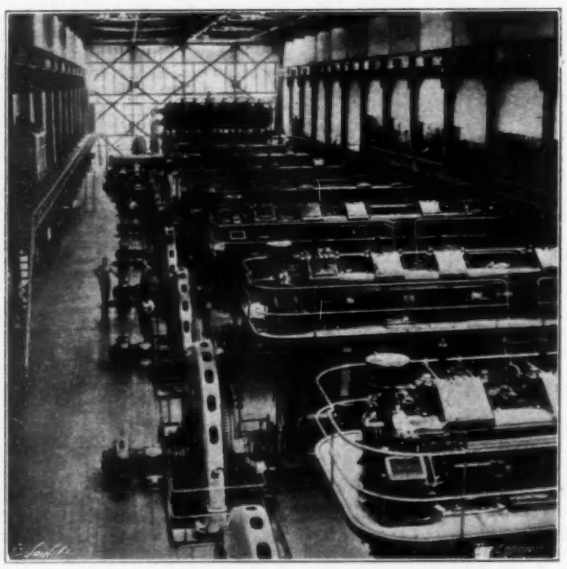

FIG. 2—INTERIOR OF TOCOPILLA POWER STATION, CHILE

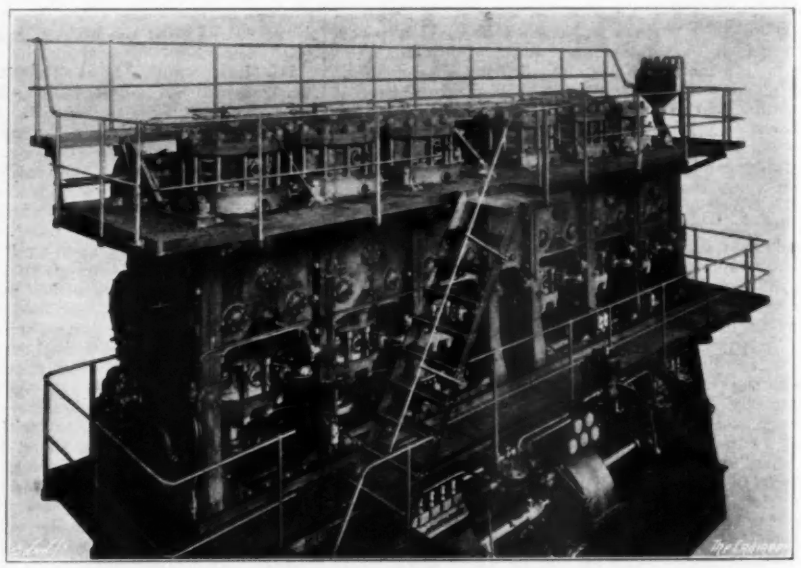

FIG. 3—3750 B.H.P. DOUBLE-ACTING OIL ENGINE

the top side of the cylinder and take the working stresses. A single-guide crosshead with an arrangement of columns designed to give a strong horizontal and transverse construction is employed.

During the tests the following fuel consumption figures were recorded :—

Load.	Fuel consumption, excluding blower and engine-room auxiliaries. Lb. per B.H.P. hour.	Fuel consumption, including blower and engine-room auxiliaries. Lb. per B.H.P. hour.
Full	0·354	0·384
Seven-eighth	0·344	0·379
Three-quarter	0·348	0·377
Half	0·350	0·407

The switches for varying the voltage delivered by the sets to the distribution lines are operated by small hand wheels mounted upon vertical pillars which are shown on either side of the switchboard at the centre of Fig. 1. They connect the exciting coils systems of the three-phase generators, either in parallel or in series, and so effect the variation of voltage as desired, according to a speed method designed by Siemens-Schuckert. A storage battery is provided which keeps both the generators fully excited, so that starting can be effected with an automatic self-controlled magnetic switch. The electromotors which drives the scavenge blowers, the circulating water and lubricating oil pumps and the other auxiliaries are coupled to the generator circuits by special switches, independently of the main switchboard, and are controlled by the engine attendant. When the generator sets are run up by turning on the compressed air the electromotors are synchronously started with the generators.

The compressed air starting for each engine is controlled by a hand wheel which is mounted on the house switchboard. Between the two hand wheels there is a smaller hand wheel which operates an automatic device worked

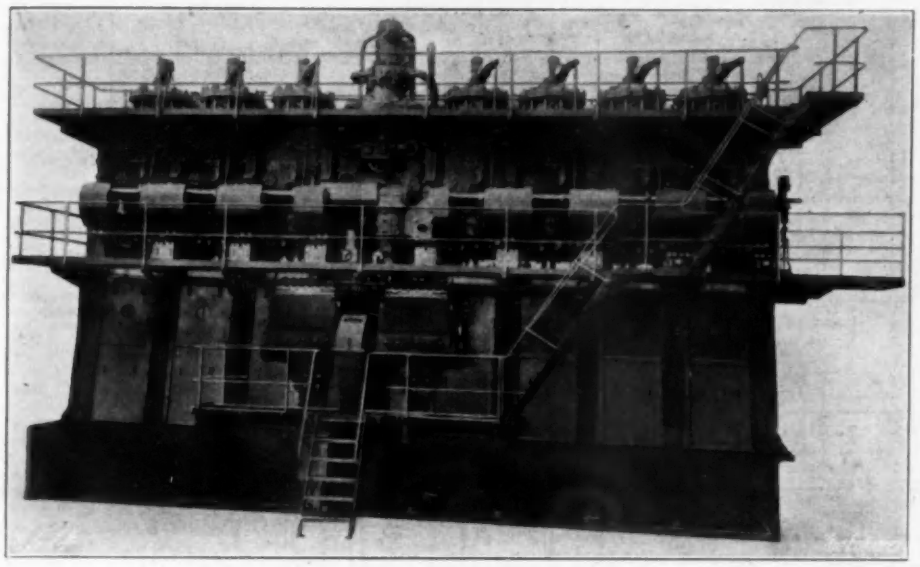

FIG. 4—SEVEN-CYLINDER 5600 B.H.P. DOUBLE-ACTING OIL ENGINE

by compressed air, which in case of emergency may be employed for quickly starting up both engines at the same time.

Only one attendant is needed to start the sets. The installation has already proved its usefulness, not only for peak load services, but also for taking emergency loads in case of a local breakdown or trouble on the distribution lines. In certain instances the whole station has been delivering its full output a few minutes after the receipt of a telephone message announcing a shut down on the high-tension line. In all such cases the sets were started up without the need for three-phase current for auxiliary purposes. For emergency starting, the total time must not exceed 3 minutes, and by simply turning the centre hand wheel through 30 deg. compressed air is admitted to the lower cylinder ends of five cylinders on each engine. The air delivery is timed by cam-operated valves, and on reaching a speed of about 40 r.p.m. firing begins and then the starting air is automatically cut off. Paralleling is carried out from a switchboard outside the engine-room by distant control. The lubricating oil pumps are engine driven, and they start up with the sets, and a special overhead tank delivers sufficient cooling water to allow the engines to be run for a period of 10 minutes before the cooling water pump is required to come into action. The turbo-blower for scavenging air is set in motion when the engine starts, so that no outside supply of current is required, which is a valuable asset for such an installation.

TWO LARGE CHILEAN POWER STATIONS.

About the same time as the Hennigsdorf station was put into operation two similar large, two-stroke, double-acting M.A.N. oil engines were put to work at the Tocopilla Maria Elena power plant of the Anglo-Chilian Consolidated Nitrate Corporation, of New York. Fig. 2 shows a view in this station, which originally consisted of seven six-cylinder, four-stroke, single-acting, M.A.N. engines, coupled to 1000-kW A.E.G. generators. The two sets recently put to work are seven-cylinder, two-stroke, double-acting motors, with separately-driven scavenge pumps. Each engine has a designed output of 5600 B.H.P. at 167 r.p.m., and the cylinder bore is 600 mm., with a stroke of 900 mm. A view of one of these engines is reproduced in Fig. 4. The power station is situated at a height of 1250 m. above sea level, and the aggregate output is 21,290 B.H.P. For the Lautaro Pedro de Valdivia nitrate works in Chile, belonging to the same owners, five 5675 B.H.P. two-stroke, double-acting M.A.N. motors are on order, which will have a total output of 23,825 B.H.P., at a height of 1500 m. above sea level. In this station the heat of the exhaust gases will be recovered in special boilers designed to supply hot water, and each engine will be complete, with its own attached scavenge pumps.

NEW TYPE OF MARINE OIL ENGINE.

We show in Fig. 3 a view of the upper part of a six-cylinder, two-stroke, double-acting, airless-injection engine, which is the first of its type, and forms one of two sets of machinery to be installed in a 15-knot, 10,000-ton cargo liner, which is now under construction at the yard of the Yokohama Dock Company, Ltd., for the service of the Kishimoto Kisen Kaisha. It has a designed output of 3750 B.H.P., at 130 r.p.m., with a bore of 600 mm. and a stroke of 900 mm., and its mechanical efficiency on trial was a little over 90 per cent. The engine ran for some time at a 15 per cent. overload of 4300 B.H.P. The fuel consumption at full load, excluding the power required for the scavenging blower, was 0·356 lb. of oil per B.H.P.-hour, and at sea, taking into account the scavenge blower, a consumption of 0·37 lb. is expected. The engine follows in design the two Hennigsdorf engines already referred to, but special reversing gear and fuel pump arrangements are fitted for marine service. The same type of machinery will be installed in a sister motor cargo vessel and also in a large oil tanker which is being built for the service of the Nippon Yusen Kaisha.

This type of engine has been standardised, and a cylinder bore of 600 mm. with a stroke of 900 mm. has been adopted. The engines are constructed in units of three to ten cylinders, the designed output of the three-cylinder engine being 1800 B.H.P. at 125 r.p.m., and that of the ten-cylinder engine 8000 B.H.P. at 160 r.p.m. At the present time no less than seventeen engines of this type, aggregating over 100 identical cylinders, are going through the Augsburg works, in addition to five engines with air injection, making 140 cylinders in all. These include an airless-injection engine with 700 mm. by 1200 mm. cylinder dimensions, and an air-injection engine with 520 mm bore cylinder and a stroke of 700 mm.

Early in the present year no less than 128 sets of double-acting engines were in commission or on order, representing about 540,000 horse-power, while 53 ships are equipped with M.A.N. two-stroke, double-acting engines, of which 30 are already in service and 23 under construction.

High-Tension Sub-station Switchgear.

AT an informal meeting of the Institution of Electrical Engineers held on Monday, March 17th, Mr. A. F. Harmer opened a discussion on "H.T. Sub-station Switchgear." He began by saying he welcomed the opportunity of placing before the members the work he had been carrying out for his company during the past few years in simplifying and lowering the cost of the gear and lay-out of high-tension sub-stations. Some engineers said they had no use for cheap gear, and if they referred to gear that had been made cheaply by cutting down material and workmanship he agreed with them. His object, however, had been to carry out schemes at a low cost by simplifying the gear, so that it became cheap without detriment to construction and material. The labour involved in fitting up this gear was very much less than usual. It was easy to handle in confined places, and there were no fine adjustments or careful lining up as was necessary with the truck type of gear. During the last few years high-tension sub-stations of a capacity of, say, 300 kVA at pressures of 6600 to 12,000 volts, had multipled to such an extent that they had become as commonplace as the distribution boxes on low-tension networks. To meet the demand in certain districts one was necessary at every street corner. At a recent meeting Mr. Twiss had stressed that point, and had stated that the old "house-to-house" system might have to be revived. With that opinion Mr. Harmer found himself in entire agreement.

Generally speaking, high-tension distribution was carried out by a ring main or a cable, fed at both ends, where there were main transforming stations for reducing the pressure from, say, 22,000 to 6000 volts. The sub-stations, which might either be on the consumers' premises, underground in road pits, in independent brick buildings, or in steel kiosks, were generally cramped in size, owing to the cost of the site or to the architect's objection to offer adequate space. Unless forced to do so, no one would construct underground pits, as they were expensive, difficult to ventilate, and the entry of water by flood or seepage was always a menace. It was, however, difficult to change gear, and it was rarely possible to provide more than a very small manhole. Everyone knew that distribution was the greatest factor in the cost of electricity, and the question arose as to whether trucks with oil switches, links, overload protective devices, and possibly ammeters and voltmeters were warranted.

The difficulty in obtaining the space to house all that gear, together with a transformer and low-tension gear, prohibited the use of trucks. In attempting to solve the problem the Metesco ring opener had been evolved. It was constructed in the form of a cubicle, 3ft. 9in. wide, 1ft. 9in. deep, and 5ft. 9in. high, with four doors. The two lower doors were hooked on, whilst the two smaller upper doors were hinged, to close over the lower doors. On each side of the cubicle there was a trifurcating box for the incoming and outgoing cables, and on the top an exit for the cable to the transformer. Each feed passed through a rotary isolator, and was coupled by an oil switch, which formed the opening link in the ring main. Between each side of the oil switch and its neighbouring isolator there was a contact jaw for the reception of one arm of an angle isolator, the other arm making contact with a jaw at the top, leading to the transformer. Thus if a ring main were broken the transformer could be fed from either side. Another form of ring opener eliminated the use of the two rotary feed isolators by employing a drop down oil switch, thus making the dimensions smaller, and in that case the trifurcating boxes were external. It was then only necessary to provide against failure on the high-tension winding, a fault that rarely occurred, and for which a suitable oil fuse would suffice.

The switch fuse employed consisted of a cast iron upper box containing the terminals and switch mechanism, and below was a steel tank which was raised and lowered by a simple pulley and steel rope, the handle or bar by which it was operated being pushed home under the tank and supported it while the nuts were fastened. Mr. Harmer showed a number of slides illustrating the various types and applications of his gear, and a good discussion followed.

Mr. R. Leach said protective devices which seemed to increase and multiply were called for in the specifications of the user, and were not the whim of the manufacturer.

Mr. S. W. Milsom was interested to learn that fuses would operate satisfactorily in oil, for it meant that the volatilised metal was efficiently dispersed. In this connection Mr. Harmer stated that the bi-metal fuse hanging in oil through a slot in a bakelite tube was extremely satisfactory. It was reliable in rupturing; did not corrode under oil like copper; and it was thick and mechanically strong. He had found that a fuse that blew at 15 ampères in air carried as much as 50 ampères in oil.

SIXTY YEARS AGO.

How long should a boiler be allowed to remain in service before it is scrapped? Sixty years ago we advanced evidence to show that sixteen to seventeen years was about the maximum safe life of a boiler working at a pressure of 40 lb. to 45 lb., and that thereafter the pressure should be lowered or the boiler scrapped. Our evidence, detailed in our issue of April 22nd, 1870, was based on experiments to destruction carried out by Mr. Peter Carmichael on two "Manchester" boilers at Dundee. They had been in use for nineteen years, and were made of "Glasgow best" iron, ⅜in. thick. They measured 25ft. in length and 7ft. in diameter, and were precisely alike. Some repairs were required, and in carrying them out it was found that the plates had become hard and brittle, so much so that in making the repairs it was difficult to prevent the plates from cracking. It was ultimately resolved to scrap the boilers, but it was decided to take advantage of the occasion and to test the boilers to destruction by hydraulic pressure, using water at 120 deg. Fah. for the test. At 80 lb. pressure the first boiler showed no signs of failure, but immediately afterwards the joint of the safety valve was blown out. At 85 lb. the joint of the feed pipe failed. At 100 lb. the longitudinal seams began to weep, and at 105 lb. a leak developed at a crack in the flue and the pump was unable to maintain the pressure. The second boiler when similarly tested developed a leak at the feed pipe at 60 lb. pressure. At 80 lb. the feed valve joint leaked, and the longitudinal seams began to weep. At 90 lb. a crack developed in the flue, and at 95 lb. one of the shell joints spouted water to an extent which rendered it impossible for the pump to keep up the pressure. Neither of the boilers on examination showed any signs of corrosion. Those responsible for breaking them up found, however, that the iron had become so brittle that great difficulty was experienced in obtaining a few sound test pieces to send to Mr. Kirkaldy. It was found that the shell plates had a mean strength of 19·7 tons per square inch, and the furnace plates one of 16·2 tons, as compared with 24·04 tons and 22·92 tons for similar unused material. We seemed satisfied in our own minds that the poor performance of these boilers under the hydraulic test was to be ascribed to the embrittling effect produced in the iron by prolonged exposure to pressure and heat. It is a coincidence that this very question of the life of boilers is discussed by Dr. Telford Petrie, as chief engineer to the Manchester Steam Users' Association, in his annual technical report, issued at the end of last week. Using all the aids of X-ray analysis and photo-micrography, he comes to much the same conclusion as we did sixty years ago, namely, that the life of a boiler or of certain parts of boilers is definitely limited by the changes which occur in the metallurgical condition of the steel produced by its prolonged exposure to modern steam temperatures and pressures.

Service Results of the Holland-America Liner "Statendam."*

By Ir. Dr. W. M. MEIJER.

When referring to the machinery of the Holland-America liner "Statendam" as a high-pressure installation, this may be considered as a true interpretation of the present-day marine engineer's opinion about high pressure, but it would hardly be recognised as such by power station engineers, who in their practice of recent years have already learned to look upon steam pressures of 400 lb. or 500 lb. as normal average pressures with which an appreciable experience has already been obtained.

It is, however, sound policy for marine engineers to follow land practice only at a safe distance, and to introduce new methods of generating propulsive power on board ship only after these have been proved to be sufficiently dependable in land practice, and even then special conditions, to which a marine installation is subjected and which differ from land installations, require careful consideration.

Recent experience with a few marine installations working at pressures in the region of 400 lb. per square inch have, however, proved not only that this pressure can be safely used on board ship, but at the same time that its adoption makes it possible to realise an economy in fuel consumption never before obtained in marine steam practice, and perhaps considered possible only by comparatively few marine engineers.

It is the object of this paper to publish the results obtained with the machinery installation of s.s., "Statendam" under actual service conditions.

General Layout of Machinery.

The installation consists of two sets of Parsons turbines, each set comprising a high, an intermediate, and a low-pressure turbine working on separate pinions which mesh into a common main gear wheel driving the propeller shafting. Steam is generated in five Babcock and Wilcox water-tube boilers, while a sixth boiler is kept in reserve to allow the cleaning of one boiler at a time during the voyage. It was the intention of the design to run the boilers at 400 lb. gauge pressure, and a margin of 30 lb. was allowed between this pressure and the safety valve load in order to prevent these valves from blowing off when the engines were temporarily slowed down. The boilers have consequently been constructed for a pressure of 430 lb. gauge. Experience has shown that there is no real need for such a great margin between the working pressure and safety valve load, in consequence of which we have found it possible in normal service to raise the working pressure to 420 lb. and to leave only a margin of 10 lb. between this pressure and the load on safety valves. This leaves a steam pressure of 395 lb. to 400 lb. per square inch at the manœuvring valves, and the drop of 25 lb. pressure in the main steam line is fully in accordance with what was contemplated in the design.

The total steam temperature at H.P. manœuvring valve was designed to be 650 deg. Fah.; it has been found in practice that this temperature is not fully obtained, the average being about 635 deg. Fah.

The turbines are arranged for two-point bleeding. Steam bled at these two stages is primarily used for feed heating in two-stage surface heaters, while from the high-pressure bleed steam is also extracted for ship's heating and galley requirements, and also to evaporate fresh water for make-up feed purposes. The principle by which we have been guided in designing the various heat and power-consuming auxiliary installations on this vessel is that steam should only be used as a heat-transferring medium for such cases where the total heat contents, including the latent heat, could completely be made effective for the contemplated purpose, and that for such purposes for which it would not be possible to utilise the latent heat of steam, if this medium should be chosen, electric energy generated by Diesel power would have preference over steam.

Further, where steam is used as a medium, this steam should be bled from the main turbines at such a stage as would appear most suitable to meet the pressure and temperature requirements for each particular purpose.

This principle naturally leads to the use of electric drive for all engine-room and deck auxiliary engines, and to the adoption of steam for all heating purposes, such as accommodation heating, galley and pantry requirements, fuel and feed water heating. For practical reasons, a few exceptions had to be allowed on this principle, which in an eventual second installation of this kind may, perhaps, partly be avoided to the further benefit of the overall efficiency. All drains from heating ranges had, of course, to be provided with efficient steam traps to ensure that the latent heat of the steam is effectively absorbed in these systems; the drains, which thus contain only water and no steam, are led to the feed tank, where they mix with the feed water delivered by the main air pumps. By carefully adhering to this principle it was possible to bleed the maximum amount of steam from the main turbines for the purpose of feed heating, as a minimum amount of exhaust steam from the auxiliaries had to be brought to the turbines themselves, as well as the losses in the single-reduction gearing.

Fairly complete measurements during normal service have been taken on the vessel's seventh voyage between Rotterdam and New York, and an abstract of the engineer's log for one complete day during the voyage, and also the actual fuel consumption for each day during the entire round trip Rotterdam-New York are given in the paper.

On November 21st–22nd measurements were taken with the special object of arriving at a figure for the boiler efficiency. The following data were obtained:—

Total water evaporated per hour	210,400 lb.
Pressure	425 lb. gauge
Temperature at superheaters	646 deg. Fah.
Temperature of feed water	300 deg. Fah.
Total heat contents of steam	1331 B.Th.U.
Total heat contents of feed water	268·2 B.Th.U.
To be added in boiler	1062·8 B.Th.U. per pound of steam
Fuel consumed in 23·35 hours:	145 tons at 18,400 B.Th.U.
Boiler efficiency:	$\frac{210{,}400\ (1331-268\cdot2)}{145\times2240\times18{,}400:23\cdot35}\times100=87\cdot38$ p.c.
Fuel per pound of steam	$\frac{145\times2240}{210{,}400\times23\cdot35}=0\cdot06611$ lb.
Evaporation ratio	15·1
CO_2 average over five boilers	12·4 per cent.
O_2 average over five boilers	5·1 per cent.
CO average over five boilers	0 per cent.
Funnel temperature	280 deg. Fah.

This high value for the boiler efficiency may be explained in the first place by the low temperature of the flue gases, and, secondly, by the circumstance that the losses through radiation are exceptionally low on account of the following:

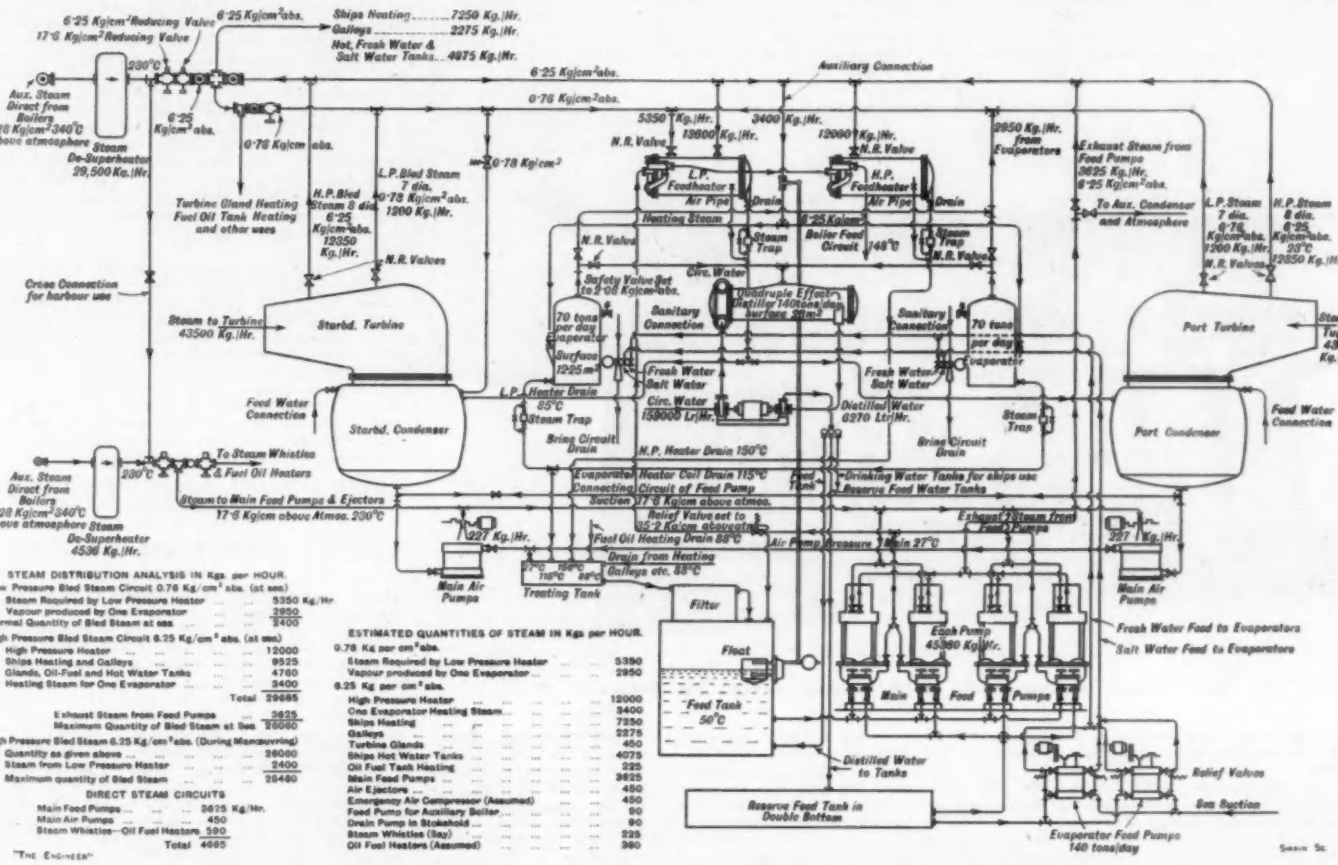
6·25 Kg/cm² Reducing Valve
17·6 Kg/cm² Reducing Valve
6·25 Kg/cm² abs.
Ships Heating ..... 7250 Kg./Hr.
Galleys ..... 2275 Kg./Hr.
Hot, Fresh Water & Salt Water Tanks ... 4975 Kg./Hr.
230°C
Aux. Steam Direct from Boilers 28 Kg/cm² 340°C above atmosphere
Steam De-Superheater 29,500 Kg./Hr.
6·25 Kg/cm² abs.
0·76 Kg/cm² abs.
Auxiliary Connection
5350 Kg./Hr.
13600 Kg./Hr.
3400 Kg./Hr.
12000 Kg./Hr.
N.R. Valve
L.P. Feedheater
H.P. Feedheater
Air Pipe
Drain
Heating Steam
Steam Trap
Boiler Feed Circuit 148°C
Vacuum Trap
2850 Kg./Hr. from Evaporators
Exhaust Steam from Feed Pumps 3625 Kg./Hr. 6·25 Kg/cm² abs.
To Aux. Condenser and Atmosphere
L.P. Steam 7 dia. 6·76 Kg/cm² abs. 1200 Kg./Hr.
H.P. Steam 8 dia. 6·25 Kg/cm² abs. 20°C 12350 Kg./Hr.
Turbine Gland Heating Fuel Oil Tank Heating and other uses
H.P. Bled Steam 8 dia. 6·25 Kg/cm² abs. 12350 Kg./Hr.
L.P. Bled Steam 7 dia. 0·73 Kg/cm² abs. 1200 Kg./Hr.
Cross Connection for harbour use
Steam to Turbine 43500 Kg./Hr.
Stbd. Turbine
Port Turbine
Steam to Turbine 43500 Kg./Hr.
Safety Valve Set to 2·08 Kg/cm² abs.
Quadruple Effect Distiller 140tons/day Surface 28m²
Sanitary Connection
70 tons per day Evaporator
Surface 1225m²
Fresh Water Salt Water
Circ. Water 159000 Ltr./Hr.
Distilled Water 6370 Ltr./Hr.
L.P. Heater Drain 85°C
Steam Trap
Bring Circuit Drain
H.P. Heater Drain 150°C
Feed Water Connection
Stbd. Condenser
Port Condenser
Feed Water Connection
To Steam Whistles & Fuel Oil Heaters
Aux. Steam Direct from Boilers 28 Kg/cm² 340°C above atmosphere
Steam to Main Feed Pumps & Ejectors 17·6 Kg/cm above Atmos. 230°C
Steam De-Superheater 4536 Kg./Hr.
Evaporator Heater Coil Drain 115°C
Connecting Circuit of Feed Pump Suction 17·6 Kg/cm above atmos.
Feed Tank
Drinking Water Tanks for ships use
Reserve Feed Water Tanks
Relief Valve set to 15·2 Kg/cm above atmos.
927 Kg./Hr.
Fuel Oil Heating Drain 88°C
Air Pump Pressure Main 27°C
Exhaust Steam from Feed Pumps
207 Kg./Hr.
Drain from Heating Galleys etc. 88°C
76°C 66°C
Treating Tank
Main Air Pumps
Filter
Float
Feed Tank 50°C
Fresh Water Feed to Evaporators
Salt Water Feed to Evaporators
Main Feed Pumps
Distilled Water to Tanks
Relief Valves
Sea Suction
Reserve Feed Tank in Double Bottom
Evaporator Feed Pumps 140 tons/day
STEAM DISTRIBUTION ANALYSIS IN Kgs per HOUR.
Low Pressure Bled Steam Circuit 0.76 Kg/cm² abs. (at sea)
Steam Required by Low Pressure Heater ... 5350 Kg./Hr
Vapour produced by One Evaporator ... 2950
Normal Quantity of Bled Steam at sea ... 2400
High Pressure Bled Steam Circuit 6.25 Kg/cm² abs. (at sea)
High Pressure Heater ... 12000
Ships Heating and Galleys ... 9525
Glands, Oil-Fuel and Hot Water Tanks ... 4760
Heating Steam for One Evaporator ... 3400
Total 29685
Exhaust Steam from Feed Pumps ... 3625
Maximum Quantity of Bled Steam at Sea 26060
High Pressure Bled Steam 6.25 Kg/cm² abs. (During Manœuvring)
Quantity as given above ... 26060
Steam from Low Pressure Heater ... 2400
Maximum quantity of Bled Steam ... 28460
DIRECT STEAM CIRCUITS
Main Feed Pumps ... 3625 Kg./Hr.
Main Air Pumps ... 450
Steam Whistles—Oil Fuel Heaters 590
Total 4665
"The Engineer"
ESTIMATED QUANTITIES OF STEAM IN Kgs per HOUR.
0.76 Kg per cm² abs.
Steam Required by Low Pressure Heater ... 5350
Vapour produced by One Evaporator ... 2950
6.25 Kg per cm² abs.
High Pressure Heater ... 12000
One Evaporator Heating Steam ... 3400
Ships Heating ... 7250
Galleys ... 2275
Turbine Glands ... 450
Ships Hot Water Tanks ... 4075
Oil Fuel Tank Heating ... 225
Main Feed Pumps ... 3625
Air Ejectors ... 450
Emergency Air Compressor (Assumed) ... 450
Feed Pump for Auxiliary Boiler ... 90
Drain Pump in Stokehold ... 90
Steam Whistles (Day) ... 225
Oil Fuel Heaters (Assumed) ... 360
Swan Sc

Diagram of the Feed and Steam Distribution Systems of the "Statendam"

Calculated Fuel Consumption and Service Results.

A diagrammatic sketch of feed arrangement and steam distribution is given in the accompanying engraving. Quantities of steam, also pressures and temperatures, as indicated on this diagram, are assumed figures which have served for the design of the installation. Of these the pressures and temperatures have been checked under actual running conditions, and the figures thus obtained are given. Steam quantities for various purposes have not been checked by direct measurement, with the exception of the total quantity of feed water, which is also given.

Based on the assumed figures given in the engraving, detail calculations of the distribution of heat and the expected fuel economy have been published in a paper read before the Royal Institution of Engineers in Holland on May 10th, 1929—see The Engineer of June 7th, 1929. I may refer for details to that publication, and only mention that the expected fuel consumption per S.H.P.-hour for all purposes as calculated therein was figured out at 282·5 grammes of oil at a higher calorific value of 10·555 calories per kilogramme, which is equal to 0·62 lb. of oil at 19,000 B.Th.U. per pound of oil. In these calculations the boiler efficiency was assumed to be 87 per cent. and the thermodynamic efficiency of the turbines was estimated at 83 per cent., the 17 per cent. loss in turbines taken to include all frictional, radiant, and conductive losses in condensation in the feed water before this could further be used to condense such part of the steam from the main turbines as it would still be able to absorb.

It is interesting to note that it has thus been possible on the s.s. "Statendam" to bleed as much as 37 per cent. of the total quantity of steam which enters the H.P. turbines, and the fact that the condenser losses are thus confined to only 63 per cent. of the total steam production does, perhaps, more than anything else appeal to the mind of the engineer.

(1) The trunks which convey the combustion air on its way down from the air heaters to the burners form an air jacket which extends over the full width and height of the boiler backs; the air thus absorbs all radiant heat from the boiler backs and returns it to the furnace.

(2) Heat radiated from the boiler fronts, sides, and tops warms the surrounding atmospheric air, which on its way up between the screen bulkheads leading to the annular space between outer and inner funnel is for the greater part trapped by the forced draught fans, which draw their air from the boiler tops and thus return this radiated heat to the furnaces.

The inlet air temperatures at the forced draught fans were, according to the log, 77–84 deg. and 95–109 deg. Fah. for the forward and after stokehold respectively.

The value of the low fuel consumption for all purposes as realised, important as it already is for s.s. "Statendam," would naturally have relatively more influence on the overall running expenses if applied to a high-powered vessel; and its financial advantages over results so far obtained on most high-powered vessels with medium-pressure turbines and steam-driven auxiliaries may amount to as much as 1 or even 2 per cent. per annum on the total capital outlay for the ship.

At the Antwerp Exhibition, which opens at the end of this month, a working model of the North Docks at Liverpool will be exhibited by the Mersey Docks and Harbour Board. Underneath the tank on which the model is built are three endless chains which carry the magnets for moving the ships, the third chain also operates the lock gates. Provision is made for a rise and fall of the water to represent tides, the use of the lock maintaining constant level in the docks. This working model is scaled 30ft. to 1in.; it has been designed and constructed by Partridge's Models, Ltd.

* Institution of Naval Architects, April 10th.—Abridged.

Railway and Road Matters.

RATIONALISATION of the German railways, it is reported from Cologne, will result in 14,000 men employed in various repair shops and other works of the system being discharged on May 1st next. The traffic receipts of the railways are said to have enormously decreased recently, but to increase rates would only result in diverting more traffic to the road motor services. It is, therefore, anticipated that wages way be reduced.

WHEN the City and South London Railway had its under-the-river section diverted in 1900, so as to run between the Bank and the Borough, the two existing tubes that carried the railway from King William-street to the latter point were thrown out of use. The railway company recently offered the disused tubes to the London County Council so that they might, if thought fit, be employed for pipe lines, but the offer has been declined.

ANSWERING a question on April 8th as to the proposals for the electrification of the former Great Northern Railway in the London area—mentioned in our Seven-Day Journal page on April 4th—Mr. J. H. Thomas said that an application from the railway company for assistance under the Development (Loan Guarantees and Grants) Act had been received, and referred to the Advisory Committee, by whom it was under consideration. Mr. Thomas added that it was understood from the application that if the work was approved for grant a commencement would be made in about nine months from the time of approval.

AT Kirkham, on the Preston–Fleetwood line of the London, Midland and Scottish, there is a junction for Lytham and Blackpool (Central Station); the junction-for Blackpool (Talbot-road) is at Poulton-le-Fylde, near Fleetwood. Between Preston and Kirkham are two intermediate stations—Lea-road and Salwick—and between Kirkham and Lytham are another two—Wrea Green and Moss Side. The *Manchester Guardian* states that now that the railway company has obtained a strong interest in the competitive road motor services, these stations are to be closed and the trains will be quickened as a consequence of the calls cut out.

THE heavily graded line of the Southern Railway that runs from the main line at Folkestone to Folkestone Harbour Station, crosses just before reaching the latter station the inner harbour by a timber opening bridge. That structure, which was erected some forty years ago, is not equal to the heavier weights of locomotives and rolling stock of the present day, and is now being renewed by a steel structure. When it is replaced, which will probably be on Sunday, May 4th, it will be possible to work the boat trains up the bank to the main line by a heavy tank engine, and thus do with one engine the work that now requires three locomotives.

THE annual report for the year ended March 31st, 1929, of the South African Railways and Harbours reports that the final installation of automatic and semi-automatic colour light signalling between Capetown and Vynberg, a distance of 8¼ miles, was completed and brought into use on February 3rd, 1929. It was provided, because, under mechanical signalling it was not possible to allow for an augmented train service, as the block sections were too long for the short intervals between trains during peak periods. But, now, the new signals are so spaced that, whilst the scheme was intended to provide for a two-minute interval between trains, it actually is possible to maintain a 1½-minute schedule. Four signal-boxes can now be closed for the greater portion of the 24 hours and other economies in signalling have been possible.

As one goes up and down the country the success of the railway companies' policy in employing containers is made manifest. Sir Josiah Stamp was quite justified at the London, Midland and Scottish annual meeting, in speaking very highly of the benefits that have resulted from their use. That company carried therein traffic of the value, in rail charges, of £200,000, and when the further orders for containers were completed there would be 2546 in use on the L. and M.S. It was not always thus. In 1916, when the late Mr. R. W. Gattie was at the height of his activities, that eminent railway publicist, the late Mr. E. A. Pratt, published as a counterblast his "A London Transport Trust: Criticism of an Impossible Scheme." Gattie had proposed containers—in which consignments would be packed just as the South-Eastern and the London, Chatham and Dover conveyed continental passengers' luggage, and as the Post Office hampers take the parcels post; but Mr. Pratt poked fun at the idea. It is true that the containers of to-day carry a through load from one firm, and that, instead of belonging to a private concern as in the Gattie scheme, they belong to the railway company, but the fact remains that their success to-day was foreseen by Gattie.

ON November 19th, 1926, a mineral wagon, when running on the down slow line near Rawmarsh, on the former Midland Railway, collapsed and its contents knocked down a signal-post which fouled the path of an up express. The result was that the side of a coach on the latter train was ripped out and seven passengers were killed. The wagon in question was privately owned, and, owing to the coal stoppage, had stood for many weeks in its owner's yard. Without the fact being noticed by either the owner's staff or the wagon examiners on the railway, the wagon went back into service in a defective condition, and the serious disaster mentioned above was a consequence. Sir John Pringle inquired into the accident, and among the recommendations in his report was one that all wagons should receive detailed and careful examination once in every ten years of their life. This question was thereupon taken up by the Railway Clearing House with the Association of the Private Owners of Railway Rolling Stock, and our contemporary, *Modern Transport*, now reports that an agreement has been arrived at that every such wagon shall be generally repaired once in every seven years, and when again ready shall have a "generally repaired" plate, bearing the date, affixed to the solebar in close proximity to the registration plate. All the wagons are to be overhauled between now and December 31st, 1937, and after that date a wagon without the plate or with a plate out of date will not be accepted for transit.

Notes and Memoranda.

A NEW iron alloy known as Ironite and developed by the Kinite Corporation, Milwaukee, U.S.A., is said to have unusual abrasive and compression resistance properties, due to its close grained and tough structure. It is cast to shape, thus saving machining. The material is an electric furnace iron alloy containing chromium, vanadium and nickel. It is suitable for forming dies, machine parts, &c.

THE Hungarian Society of Natural Science has organised for its ninetieth anniversary an interesting exhibition of portraits of the leading Hungarian scientists of the last century, together with their original manuscripts, correspondence, and descriptions of their achievements. One of the most interesting exhibits is an electric dynamo constructed by the Hungarian inventor, Anyos Jedlik, more than a century ago.

THE number of furnaces in blast at the end of March was 157, a net decrease of 5 since the beginning of the month. The production of pig iron in March amounted to 665,800 tons, compared with 607,000 tons in February and 590,500 tons in March, 1929. The production includes 204,200 tons of hematite, 266,400 tons of basic, 139,800 tons of foundry, and 27,700 tons of forge pig iron. The March output of steel ingots and castings amounted to 826,100 tons, compared with 776,400 tons in February and 859,900 tons in March, 1929.

THE new three-engined metal monoplane air yacht which has been constructed by the Supermarine Aviation Works for the Hon. A. E. Guinness is equipped with Marconi apparatus equivalent in power and range to the normal wireless installation on a sea-going vessel of 5000 tons. The transmitter and receiver are of the Marconi ½-kW AD8 type, giving a telegraphy or telephony range up to 400 miles. A direction finder is included, and the equipment is completed with a broadcast receiver. The air yacht carries a crew of three and has accommodation for six passengers.

WHAT will be the largest single pumping station ever built is to be erected by the city of Detroit to bring more water from the Detroit River and will probably be in operation in 1932. This plant, to be known as the Springwells station, will use centrifugal Worthington pumps of the latest design and of great size. The main power-supplying equipment is designed for an ultimate capacity of 30,000 kW. It consists of two 5000-kW and two 7500-kW turbo-generators and a 5000-kW transformer bank. The transformers will be joined to a separate source of central station power. Auxiliary power will be furnished by three 500-kW generators. Steam will be extracted from the stages of the turbines and used for heating the building. Proper ventilation for the river tunnel is provided by two General Electric centrifugal compressors, each supplying 9000 cubic feet of air per minute at a pressure of 2 lb. and driven by 120 H.P. induction motors.

OUR contemporary, the *Wireless World*, calls attention to the fact that an interesting situation has arisen in connection with the licensing of manufacturers of wireless receivers under various patents. Since broadcasting began a general licence has been available from the Marconi Company, under which manufacturers made use of any of the Marconi Company's patents, these patents being generally considered to cover most of the circuits likely to be employed in receiver design. Now, however, Standard Telephones and Cables, Ltd., is offering to the British wireless manufacturer a licence to manufacture under more than sixty patents, which it owns, and the manufacturer may find himself in rather an embarrassing position when it comes to making the decision as to which licence to take, especially as a superficial inspection of some of the patents of the respective companies under which licences are offered suggests that there may be overlap and interlocking of subject matter.

A DETERMINATION of the laws governing the transfer of heat from a moving gas stream to a bed of broken solids, such as iron ore, coke, and limestone, is one of the essentials in the development of a complete quantitative theory of the blast-furnace process. The burden of ore, coke, and limestone acquires heat as it settles counter-current to the rising gas stream. Proper thermal and chemical preparation of the burden before it reaches the hearth depends upon heat acquisition. The efficiency of the furnace above the tuyeres is directly related to the efficiency of heat transfer and to the overall efficiency. The United States Bureau of Mines, in co-operation with the University of Minnesota, has found that the coefficient of heat transfer from a gas stream flowing through a bed of broken solids varies as the 0·8 power of the gas velocity, and is practically independent of temperature. A general relation has been found between voids and heat transfer, but data are not sufficient to determine a reliable mathematical relation. It seems likely that a definite relation between the resistance of beds to gas flow and coefficient of heat transfer will be developed.

IT is now fairly well established that the use of steel containing small percentages of copper, of the order of 0·2 per cent., provides considerable resistance against atmospheric corrosion. In tests carried out in Germany upon steel sleepers for railway use it was found that the loss of weight by corrosion of copper-bearing steel after a seven years' period of test was very appreciably less than with corresponding steels having no copper. In shipbuilding, too, the use of copper steel is expanding, especially for decks, erections, masts, and funnels exposed to severe atmospheric corrosion. One observer estimates that unpainted copper steel has from 2½ to 2 times the life of ordinary steel, and his tests showed that where copper-free steel had lost 70 per cent. to 90 per cent. of its thickness, copper-steel, under identical conditions, had only 4 per cent. wastage. In view of the high cost per mile of electrical transmission lines, and the necessity for prolonging their life and reducing upkeep, it is noteworthy that for the Central England electricity scheme transmission towers have been constructed of copper-bearing steel. The towers are manufactured by the Horseley Bridge and Engineering Company, Ltd., from copper-bearing steel supplied by the Frodingham Iron and Steel Company, Ltd., one of the branches of the United Steel Companies, Ltd.

Miscellanea.

IT is announced that by July 1st the new Welland Canal in Canada will be fully open to traffic.

HYDRO-ELECTRIC plants to the extent of 100,000 horse-power are to be installed on the Mississagi River, Ontario.

THE ninth annual exhibition of the Model Railway Club is to be held at the Kingsway Hall, London, from April 23rd to April 26th.

THE Shanan power station, on the Ual River in India, is to comprise four units of 12,000 kW each, which are being supplied by the British Thomson-Houston Company.

TWO new bridges are to be built across the Nerbudda and the Godaria rivers for the Great Indian Peninsular Railway by Braithwaite and Co. They will involve the erection of some 3500 tons of steelwork.

THERE are now licensed in Shanghai well over 12,000 motor vehicles. Among these there are Fords 825, Morris 794, and Chevrolet 625. The records for the last year were Fords 778, Morris 772 and Chevrolet 591.

WORK on the new 1,000,000-dollar terminal of the Canadian Steamship Lines at Hamilton, Ontario, is sufficiently advanced to accommodate the large freighters which will pass through the new Welland Canal.

A NEW 478ft. bridge built by the Canadian Pacific Railway on its main line at Salmon River, B.C., was opened to traffic in March. The new span replaces the former one built in 1893. The new bridge contains 1,327,697 lb. of steel.

IT is proposed to utilise the potential power of the Teesta River, in Bengal, for electrical power production. There is the opportunity of developing a head of 320ft., and it is said that as much as 225,000 kW can be produced.

A TEMPORARY post of Superintending Engineer has been recently created for investigation into the probable effect of the Bakhara Dam scheme of the Punjab Government on the discharge of the lower Indus and supplies to canals in Sind.

THE contract for the superstructure of the 2,500,000-bushel unit of the grain elevator, being erected in Kingston, Ontario, for the Canadian Steamship Lines, has been awarded to the Carter-Halls-Aldinger Company, Ltd., of Winnipeg.

IT is noteworthy that the Canadian International Paper Company is installing fired boilers, with an aggregate capacity of 5200 horse-power to supplant electrically heated boilers at its Gatineau mill, in order to release electric power for other purposes.

FOLLOWING representations by the various Councils in the Dolgelly area Mr. Haydn Jones, M.P., has secured from the Lord Privy Seal—Mr. J. H. Thomas—a promise to send a commission to Merionethshire to inquire into the possibility of reopening the local gold mines.

A GENERAL increase in world crude rubber consumption in 1930 and a decrease in world production is indicated in a consensus of estimates by European and American authorities, according to the U.S. Department of Commerce. The estimates for world consumption average 840,570 tons, as compared with the 1929 consumption of 790,000 tons.

THE Southern Canada Power Company, Ltd., is applying to the Quebec Public Service Commission for approval of its plans and authority to begin the construction of a 6,000,000 dollar power development at Spicer Rapids on the St. Francis River, 6 miles north-west of Drummondville. The proposed new power supply would be an important factor in extending the industrial district which the company has created around the Hemming's Falls hydro-electric plant further up the river.

THE total cost of Government works, including Air Force reconnaissances, construction of harbour facilities and building of the railway in connection with Hudson Bay to date amounts to 41,878,225 dollars, according to a return tabled in the Canadian House of Commons. The largest item in this total is taken up with the construction of the railway, which has cost 29,609,240 dollars. Works at Fort Churchill so far have cost 4,594,700 dollars, while those at Port Nelson, which has now been abandoned, cost 6,274,218 dollars.

ACCORDING to Dr. Waddell, up to date the longest arch-span constructed in America is that of the Hell Gate Bridge in New York City, engineered by Dr. Gustav Lindenthal, and completed over a decade ago. It has a span of nearly 1000ft.; but that limit will soon be greatly surpassed by the Bayonne Bridge over the Kill van Kull, now under construction by the Port of New York Authority, for it will have a span of 1675ft. It will be the longest arch-span in the world, being 25ft. longer than that of the Sydney Harbour Bridge, Australia, now under construction.

AT a recent meeting of Committee A-2 of the American Society for Testing Materials, the following definition was recommended for adoption as standard:—"Wrought iron is a ferrous material aggregated from a solidifying mass of particles of highly refined metallic iron, with which without subsequent fusion is incorporated a minutely and uniformly distributed quantity of slag." The Committee also voted to delete the definition of "puddling" from the list of definitions, since no other process of manufacture is defined by the Society; the process clauses of all specifications covering wrought iron products will be revised to eliminate reference to the process of manufacture.

A BEAM radio-telephone service has been opened to the public between Madrid and Rio de Janeiro, Brazil. The stations conducting the new service in Spain are of the short-wave beam type and were erected by Marconi's Wireless Telegraph Company at Aranjuez, near Madrid. In addition to the telephone service, a commercial telegraph service is in operation. For use in these circuits special receivers have been constructed by the Marconi Company on behalf of Transradio Espanola, the Spanish company to which the stations belong and which carries on the services between Spain and other countries. The South American end of the service is controlled by the Companhia Radiotelegraphica Brasileira.

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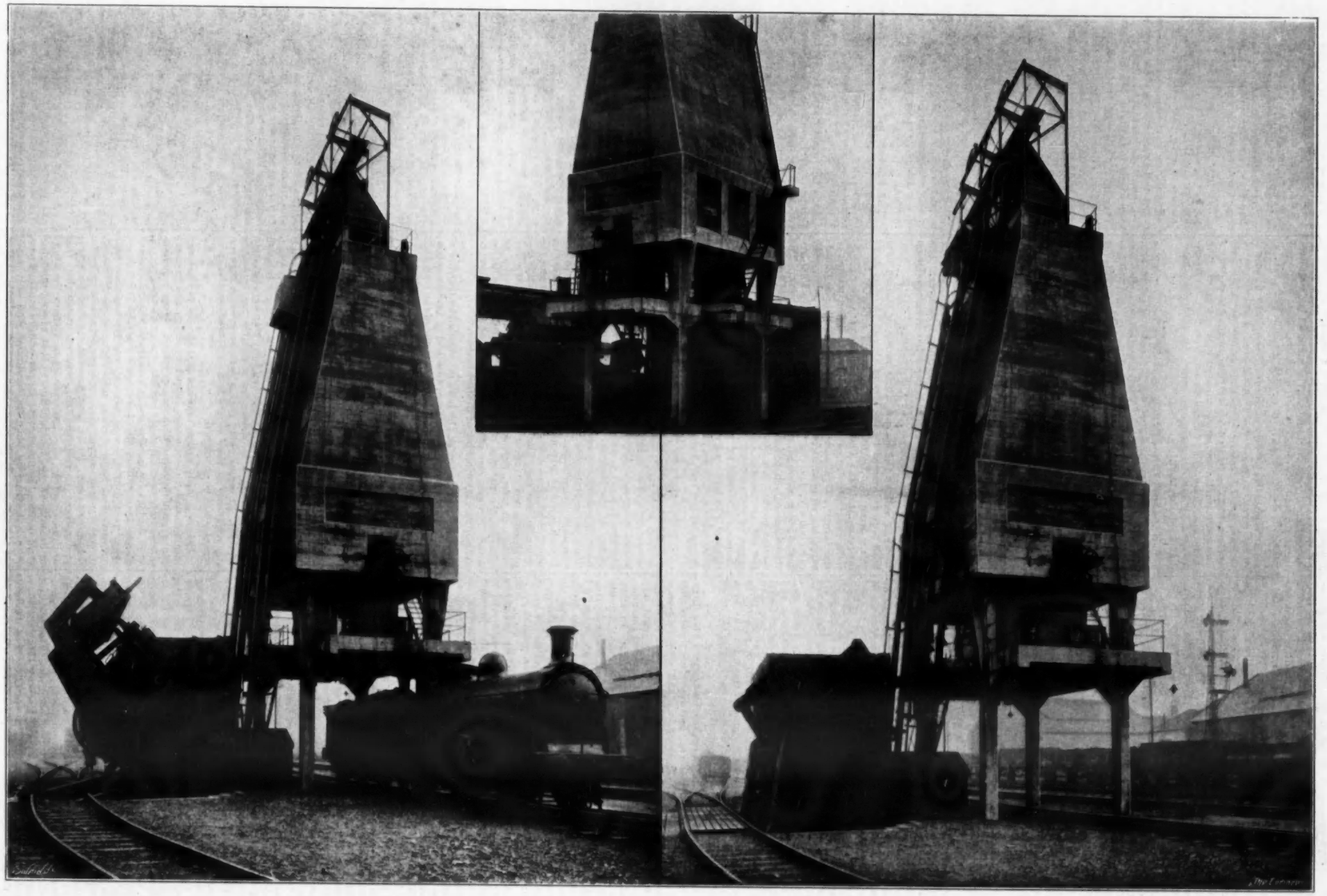
(*For description see page* 442.)



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THE ENGINEER.

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APRIL 18, 1930.

Surge Investigations.

IN an effort to learn more about the electrical behaviour of transmission lines under transient conditions many investigations have been carried out by American engineers. The study of surges set up by switching, arcing and lightning has resulted in the publication of many technical papers, most of which, as indicated in an article appearing in our last issue, deal with lightning surges. Fortunately, in this country lightning is much less troublesome than it is in many other parts of the world, but its effects on transmission systems cannot be entirely ignored. One of the most important contributions on lightning was the Kelvin Lecture delivered last year before the Institution of Electrical Engineers by Dr. G. C. Simpson, who demonstrated, among other points, that, contrary to what many seem to suppose, practically all troublesome surges are attributable to direct strokes and that surges caused by induction are of little importance. In this country, however, engineers appear to be more concerned with other kinds of surges which have given rise to very real trouble in certain parts. In a paper on "Some Surge Investigations on Overhead Lines and Cable Systems," read before the Institution of Electrical Engineers on Thursday, April 10th, the authors, Messrs. S. W. Melsom, A. N. Arman and W. Bibby, show that brushing at the insulators of overhead lines caused by salt deposit from the sea has been responsible for serious disturbances. A line in South Wales, investigated by the authors, was 20 miles from the sea, yet with an abnormally dry south-westerly wind salt was firmly deposited on the insulators. Whilst the dry wind continues the danger of a complete flash-over is not great, but flashing occurs when the humidity of the air returns to a more normal value. The particles of the salt then take up moisture from the air and the surfaces of the insulators are covered or partially covered with a good conducting film. If the insulators are not cleaned after the salt storm part of the salt remains on them and surging occurs. The seriousness of the trouble can be gauged from the fact that on one occasion brushing at the insulators was responsible for surging over a period of 2½ hours. Finally, at 8.15 p.m., the breaker tripped and could not be replaced until the following morning. Even then surging ultimately caused the breaker to be tripped again. Not until all the sealing end insulators had been scrubbed and made clean could the line be switched in. Many records on this 33-kV South Wales line show similar surges caused by salt deposits emanating from the sea. In common with other investigators, the authors have found that surges produced by switching are not on the whole unduly troublesome, although one or two rather serious surges of this nature are recorded. Investigations in the Midlands on a mixed system consisting of a great deal of cable and several lengths of overhead line showed that whilst salt troubles were non-existent, certain other more or less inexplicable surges were experienced which, however, ceased when many of the line insulators had been replaced.

These investigations clearly indicate that the design of porcelain insulators for outdoor use still calls for consideration. A thorough investigation into the performance of insulators both under dry and clean and wet and foul conditions is therefore being made. Apparatus has been devised to imitate as far as possible the dry salt conditions mentioned, and conditions very near to the actual are said to have been reproduced. A finely divided spray of salt solution from an atomiser is injected into a current of air from a rotary blower and then on to the insulator under test. The drying action of the strong air blast evaporates the water from the salt spray, thus leaving salt particles of small dimensions which are deposited on the porcelain. Tests have been made under rain, fog and salt conditions, and it has usually been found that, whilst pin insulators prove on the whole to be satisfactory, the sealing end insulators give trouble and that quite severe brushing occurs at voltages less than the working pressure. Tests involving the determination of the field diagram of the surface potential distribution on a large number of insulators of different types and sizes and under all atmospheric conditions have shown that, although it is not possible to make any appreciable improvement in the final flash-over voltage, the pressure at which brushing becomes serious can be materially raised. The flash-over voltage is invariably higher than the line voltage, and it is evident from the klydonograph records that brushing is the vital factor that calls for consideration. The authors point out that when a line or a portion of it can be taken out of service a great deal can be done by systematic cleaning. This course, however, is not always a possible solution to the problem, as, apart from the high cost involved, the deposit may accumulate too suddenly to be dealt with; in fact, the salt carried inland by a single storm is sometimes sufficient to put a coastal line out of action. While some people are inclined to grapple with the difficulty by over-insulating the line, the authors contend, and, in our opinion, rightly, that something more than that is desirable. For very bad positions special arrangements might be made and the experience in South Wales indicates a line that might be taken. The whole of the observations in this quarter showed that roughly 80 per cent. of the surging occurred on the line nearest to the direction of the dangerous wind, which indicates that some system of shielding might eliminate a great deal of the trouble. The subject of transmission line insulators received a good deal of attention at the Extra High Tension Conference held in Paris last year, and one of the papers read on that occasion dealt specifically with methods of improving the insulation of high-voltage transmission lines in the neighbourhood of the sea coast. The authors, Messrs. A. Montandon and M. G. Gravier, described a special oil bath insulator, which is said to have made it possible to operate 70-kV lines in Morocco, where, owing to salt deposits, all other insulators failed to give satisfactory service. Much useful information on the influence of atmospheric conditions on the performance of insulators was also given in a paper by Messrs. B. L. Goodlet and J. B. Melford. Troubles such as those which Mr. Melsom and his colleagues describe are not confined to Great Britain, and it is desirable that the work of engineers in other countries should be studied, but we know of no paper other than the one under consideration that deals with surges set up by salt deposits on insulators.

In carrying out the investigations the authors have resorted to methods adopted in America. The apparatus employed for the measurements was the klydonograph, which will record surges of very

short duration and over a wide range of frequency. With certain modifications all the apparatus used for the tests was originally devised in America, but the researches themselves can scarcely be regarded as a repetition of those carried out elsewhere. While American engineers have confined themselves largely to surges set up by lightning and switching operations, Mr. Melsom and his colleagues have concentrated mainly on surges produced by brushing on transmission line insulators and have provided information that can scarcely fail to interest engineers who are responsible for the operation of overhead lines in the vicinity of the coast.

French Shipping.

As a means towards improving the economic situation of their industry, British shipbuilders recently formed a company, registered as National Shipbuilders' Security, Ltd., the object of which is to purchase and dismantle redundant and obsolete shipyards. It is hoped that this policy of cutting out the "dead wood" and of concentrating the available work in the remaining yards will lead to increased employment and improved financial returns. The remedy in view may appear to be in the nature of a somewhat drastic surgical operation. It is therefore not without interest to note the corresponding situation which exists in French shipyards and the proposals which are being made to alleviate it. One obvious remedy for unemployment in shipyards is to provide shipowners with the means to purchase new vessels, and this is what the French Government has endeavoured to do with its system of maritime credits. French owners, however, do not want more ships, as they already possess all the tonnage they require, but they must have modern ships, and if they can order them there will be work for the shipbuilders. In 1914 France had 2,555,000 tons of shipping, and in 1922, after the surrender of German vessels and with new construction, this figure was increased by a million tons. There was then some scrapping of old ships, which reduced the total, but by 1929 it had risen again, and stood at 3,448,000 tons. A serious aspect of the situation is that while there has been an addition of new vessels to the French merchant fleet it has not benefited the French shipyards to any great extent. Many of the ships, amounting to quite a respectable tonnage, were supplied by Germany on account of reparations. Others were purchased abroad, principally in Great Britain and Northern Ireland. A close inquiry revealed the fact that French shipyards were quite unable to compete in price with foreign shipbuilders. The seventeen yards in France are declared to have worked last year at only 26·7 per cent. of their capacity. This serious matter is now engaging the attention of a Parliamentary Committee in the hope of arriving at some definite and acceptable shipbuilding programme and the establishment of a policy of assistance to the industry.

Shipowners in France are in a particularly difficult situation on account of the long period of monetary deflation and the subsequent stabilisation, followed by heavy fiscal charges, which have not allowed them to write off enough for depreciation and to replace their older vessels. Before they can rejuvenate the merchant fleet, they must, they argue, be able to make bigger profits and they can only do so by securing a larger share of the international carrying trade. In other words, they must not pay more for their ships than foreign competitors, and they must not be burdened by heavier charges. For a long while past the balance of trade has been becoming more and more unfavourable, and the deficiency can only be made good by invisible imports, the most important of which, for the French, are to be found in a larger participation in international sea-borne traffic. Owners are showing much enterprise in attaining this end. French ships are frequenting foreign ports in larger numbers, and with the new vessels that have been added to the fleet, they appear to be meeting with some success. This fact convinces them that with the elimination of old vessels and their replacement by new ships, they will eventually secure an acceptable share of foreign traffic. The only way to accomplish this end is to write off the cost of vessels in as short a time as possible, so that the fleet will always be up to date; but unless foreign freights bring the owners ample profits there is little hope of the depreciation keeping pace with the economic requirements of the situation. The future, therefore depends upon what the State can do to alleviate the charges on owners and what can be done to enable French shipyards to provide them with vessels under conditions that will avoid the necessity of placing orders abroad. As the interests of shipping are nationally more important than those of the shipbuilding industry, it is hardly possible that anything will be done to prohibit owners from purchasing ships in foreign yards so long as they have no alternative. The objection to this course is, however, so strong that every possible expedient will be tried to render owners dependent upon home shipyards, although, at the moment, no definite scheme has been evolved whereby this end can be accomplished. The system of maritime credits offered to shipowners who place orders with French shipbuilders has failed, because it is far from making good the difference between home and foreign prices. Examples given recently show that the difference is so hopeless, so far as cargo steamers are concerned, that a complete reorganisation of the industry will have to be carried out before there can be any prospect of the shipyards working under economical conditions.

While the interests of shipping are greatly superior to those of shipbuilding, there can, nevertheless be no question of allowing the yards to languish as they have been doing for years past. As a maritime Power, France cannot be dependent on foreign builders. The great disadvantage in the economical construction of merchant steamers under which French shipbuilders labour is a result of the geographical situation of the yards, far removed as they are from the sources of raw material supply. What remedies can be applied to give vitality to the industry have long been the subject of inquiry. What will be the outcome and what measures will be proposed when new legislation is introduced for the protection and development of the shipbuilding industry, it is impossible to say. The situation is so complicated that the remedy must be of a drastic character if it is to produce really satisfactory results. Meanwhile, other countries have sought to put their yards in order by concentration and rationalisation, and unless French builders can do likewise they will find the existing margin between their own costs and those abroad widen every year. Other factors to be reckoned with are increased wages and dearer raw material. All attempts made so far to induce mill and forge owners to supply material at specially reduced rates for shipbuilding purposes have failed. Competition, too, is becoming keener, and Italy in particular is making a determined effort to secure foreign orders for her shipyards. The outlook therefore is not bright for the French shipbuilding industry. Doubtlessly, something will come of the programme of reorganisation which is now being prepared, but as the guiding principle of the shipping policy is that owners must be able to purchase French-built vessels at the same prices as those quoted by foreign shipbuilders, a satisfactory solution will need much thought and circumspection.

An Unusual Railway Accident.

On the evening of November 20th last, a goods train belonging to the Somerset and Dorset Joint Committee descended the 2 miles approaching Bath, where the gradient is 1 in 50, at such a speed—estimated at from 50 to 60 miles per hour—that it failed to negotiate the entrance into the goods yard and was derailed. The driver was killed and two other railway servants lost their lives by being caught by the debris. The fireman was seriously injured. The accident was inquired into, on behalf of the Ministry of Transport, by Colonel Trench, whose report on it has now been issued. The cause assigned was one of which we find no similar record in our card-index of the accidents inquired into since the Act of 1871 came into force. To understand the circumstances it is necessary to know that, situated between Midford and Bath, a distance of 4 miles, there is Coombe Down tunnel, 1826 yards long. This tunnel is approached from the south by rising gradients as follows:—393 yards of 1 in 330; 366 yards of 1 in 350, 440 yards of 1 in 55, 100 yards of 1 in 100, and 221 yards of 1 in 50. The first 1368 yards in the tunnel rise 1 in 100 to the summit and, after being level to the northern mouth of the tunnel, the line falls 1 in 50 for the 2 miles to the point at which the Somerset and Dorset joins the main line into Bath of the London, Midland and Scottish. The weather on the day of the accident was cloudy and damp, humidity being high and the day temperature between 51·6 and 54·3.

The train consisted of 37 wagons, of which 33 were loaded, and a 20-ton brake van. None of the wagons had a power brake. Their total weight is estimated at 493 tons. The engine was No. 89, of the 2–8–0 type, with six-wheeled tender. It weighed 111 tons, had a boiler pressure of 190 lb. and the tractive power at 85 per cent. boiler pressure was 16 tons. The percentage of brake power on the engine and tender combined was 71·7 per cent. The train had had to come to a dead stand at Midford. As the driver was killed, the story as to what happened there and afterwards has to be told by the signalman, fireman and guard. The signalman stated that the driver came to the signal-box to obtain possession of the tablet for the section to Bath—the line is single—and said that he had a heavy train and was having difficulty with the steaming of his engine. He said also that he thought he would have a job to get through the tunnel owing to the load and the condition of his engine. The fireman apparently did not share his mate's views about the engine. He had a good, clear fire with which his driver appeared satisfied, and just before entering the tunnel the boiler pressure was about 175 lb. The engine had not been slipping at all and the sanding gear was in good order. All the witnesses were agreed that under normal conditions the atmospheric conditions in Coombe Down tunnel were not such as to involve any risk, or anything more than a degree of discomfort. Occasionally, however, conditions were very bad, as a result of a combination of adverse factors, such as smoke from trains immediately preceding, an engine labouring heavily and, possibly, slipping, together with unfavourable weather conditions, with high humidity and absence of wind. All these factors, it should be noted, were present, to a marked degree, on the occasion of the accident. The guard considered that the train passed through the tunnel distinctly more slowly than was customary, and that the atmosphere was thicker than usual; on more than one occasion he looked and turned his lamp on the wall to make sure that the train had not stopped. The fireman said that shortly after entering the tunnel he found the atmosphere very hot and smoky and it caused him to cough violently. He wrapped his coat round his head and sat down on his own side of the tender. The engine was running tender first. At that time, as far as he was aware, the driver was standing on his own side of the footplate and was not showing any special signs of being affected by the smoke or heat. The fireman recollected nothing more after that, and the driver is not alive to tell what then happened. It is clear that the train was in the tunnel for a period considerably greater than usual—probably between 11 and 13 minutes for the 1 mile of tunnel, in contrast to the customary 13 minutes for the whole 4 miles. There was no whistling from the engine and none of the several witnesses, who were attracted by the noise of the train after it left the tunnel, observed anyone on the footplate. After the wreck the driver was found lying on the footplate and the fireman above him, which suggests that the driver had collapsed first and the fireman slipped off his seat afterwards. The condition of the engine controls after the accident favoured this opinion. As regards the alleged bad steaming of the engine it should be said that whilst the fireman did not corroborate his driver, it was admitted by the railway company's officers that from time to time they had received complaints as to time lost because of bad steaming of engines of this class and that they had put on inspectors to ascertain the cause, but had been unable to find any defect.

In concluding his report and making the customary recommendations, Colonel Trench says that for fifteen years this class of engine, with practically the same maximum loading, has been traversing this line. Although the chance of a recurrence of such a combination of adverse factors may be remote, the risk should not be taken. The most obvious way to avoid it is by improving the ventilation of the tunnel—either by a vertical shaft or by some arrangement of a fan and forced draught. As to the first named suggestion, it may be noted that the depth of ground above the tunnel varies for the greater part of the length from 270ft. to 300ft. above rail level. Either scheme would, therefore, be costly and could hardly be justified, at any rate, until simpler schemes had been tried. There are, however, two minor remedies. One is to reduce the permissible loading and the other is that trains for which there is not a clear road through from Midford to Bath should be kept back at Wellow, the next station 2½ miles to the south, and so that they could approach the tunnel with a longer run at speed. A feature of this class of engine—which was designed by Sir Henry Fowler and was illustrated in The Engineer of April 24th, 1924—is that they are too large to be turned on the table at Bath. They, therefore, always travel tender first towards Bath and, presumably, because of that circumstance, the first five had cabs for the tender. Subsequently, the cabs were removed in view of the complaints that they were inconvenient and uncomfortable. It is evident, therefore, that when the engine is running tender first, the cab acts as a cup that fills the tunnel and collects the smoke and fumes. On the other hand, the smoke from the engine is left behind. Opinions among the drivers concerned differ as to which practice, engine or tender first, is the better. Colonel Trench suggests that before deciding to continue the present system indefinitely the company should conduct some practical experiments.

Wireless Telephone Developments between North and South America.

Wireless telephone service over the first two-way circuit linking the continents of South and North America, was established on April 3rd by the Compania Internacional de Radio (Argentina) and the American Telephone and Telegraph Company, when more than 277,000 telephones in Argentina, Chile and Uruguay were connected with 21,600,000 telephones in Mexico, Cuba, the United States and Canada.

An exchange of greetings between his Excellency, President Carlos Ibanez Del Campo, of Chile, and his Excellency, President Juan Campisteguy, of Uruguay, and President Herbert Hoover, of the United States, marked the ceremonies coincident with circuit opening. They were followed by felicitations between David Hermosilla, Minister of the Interior of Chile, Rufino T. Dominquez, Minister of Foreign Affairs of Uruguay, and Acting Secretary of State Cotton of the United States. The new circuit was then thrown open for public use, not only from special telephone booths in cities where terminals exist, but to and from any telephone subscriber in the countries concerned.

Terminals for the circuit are situated near Buenos Aires and New York respectively. At the former point the Compania Internacional de Radio (Argentina) transmitting station is at Hurlingham, adjacent to the Buenos Aires–Madrid transmitting station, while the receiving stations for both New York and Madrid are at Platanos. The new stations are similar to those used in the Buenos Aires–Madrid service, which was initiated on October 12th,

1929. The Hurlingham Station is on a 200-acre site, approximately 12 miles from Buenos Aires. Power is supplied over high voltage cables from Hurlingham village. There are seven steel towers at the station, each 180ft. high, the tower line being almost a third of a mile long. The wires, forming each of three aerial systems, are not strung on top of the towers, but, like a coarse screen or curtain, hang vertically between the towers to within 3ft. of the ground. At the receiving station at Platanos the aerials are designed with a similar reflector effect to secure better reception of signals coming from a particular direction. A considerable advantage in transmission is gained through this latest development in aerial construction at both stations.

Both the transmitting and receiving stations are of the most modern design and construction from the technical and operating standpoints, and special provision has been made to ensure satisfactory operation of the circuit by the installation of spare equipment. On account of the high voltages used, particular attention has been paid to the safety of the operators. Interlocking door devices that immediately shut off the power, a cooling system control for the high-power amplifiers, and devices precluding the operation of apparatus while operators are making adjustments, all go towards making these two stations as safe as is humanly possible. There are also several ingenious devices to facilitate the quick detection of trouble.

Land telephone lines are used to connect Santiago and Montevideo with Buenos Aires. From Santiago these lines cross the Andes Mountains, while at one point, the Montevideo land lines go under the Rio de la Plata, one of the widest rivers in the world. The distance between the South and North American terminals is approximately 5290 miles. The circuit runs at a slight angle to the Meridian, and has its centre near the Equator, which makes for favourable average ether and transmission conditions.

Rural Electrification.

FOR the benefit of all authorised undertakers having rural areas of supply and various associations interested in the question of rural electrification, the Electricity Commissioners have issued a memorandum, entitled "Considerations bearing upon the Electrical Development of Rural Areas," which we reprint below :—

Although much work in connection with electricity supply in rural areas has been carried out during the last few years, the Commissioners have felt that the development of such areas has not been as rapid or on so large a scale as is economically possible, especially as gas is not usually in competition.

The prospects of the electrification of rural areas being proceeded with more rapidly on a profitable basis are affected by a number of factors, the more important of which, though not necessarily in order of merit, are as follows :—(*a*) The availability at a reasonable price of electricity in bulk at appropriate points in or near the rural area to be developed. (*b*) Minimum costs of transmission and distribution from the bulk supply points, by the liberal use of overhead lines for these purposes and the co-operation of the local authorities and landowners concerned in the granting of the necessary facilities ; and by the adoption of standardised voltages and equipment and a carefully planned lay-out for the area as a whole, the collective aim being the fullest possible economy in capital expenditure consistent with reasonable continuity of supply and safety. (*c*) The construction of a transmission and distribution system in anticipation of demand, so as to foster rapid development, instead of providing supplies in the area by sporadic and irregular extensions as and when a demand arises. (*d*) The adoption of a suitable two-part tariff which by its character will serve to encourage extensions in the use of electricity once a supply is available. (*e*) The adoption of a scheme of assisted wiring so that new consumers are not forced to make a large cash payment for connection to the supply system. (*f*) The provision of a service whereby electrical cooking and heating apparatus, &c., and electric motors are provided on hire or hire purchase and efficiently maintained at a low cost. (*g*) Active propaganda, including showroom and other demonstration and canvassing of likely consumers.

The progressive construction of the new "grid" system by the Central Electricity Board, supplemented by the establishment or extension of secondary transmission lines by the Board and other undertakers, will result in a network of transmission lines from which electricity in bulk can be made available at a reasonable price over much more extensive tracts of Great Britain than hitherto, and thus provide greatly increased facilities for the development of rural areas, where the prospects of a remunerative demand for electricity exist.

Economies in the costs of transmission and distribution will result from the adoption of standard voltages for these purposes, and by the simplification and standardisation of equipment such as overhead lines, transformers and switchgear, thus making possible the large-scale production of suitable types of equipment with consequent savings in capital cost. As the result of a careful review of the technical and other considerations involved, the standardisation of 11,000 volts for the principal transmission systems for rural areas, and of alternating current at 400/230 volts for low-tension distribution is advocated. It is felt that with the present standard of technique, the advantages in the form of economy in conductors and reduced voltage drop for a given load accruing from the adoption of 11,000 volts, in preference to voltages ranging from 3300 to 6600 volts, more than outweigh the slightly greater present-day cost of transformers and switchgear for 11,000 volts. For the purposes of supply in smaller villages and to isolated farms and residences off the route of the main 11,000-volt transmission lines, the use of single-phase extensions also at 11,000 volts is advocated in appropriate cases where the balance of the system can be maintained without particular difficulty. With regard to transformers, the investigations hitherto made point to the conclusion that in the generality of cases the requirements of small villages and isolated consumers could be met by the adoption as standard sizes of pole transformers of 50, 20, and 10 kVA for three-phase, and 20, 10, and 5 kVA for single-phase supplies. The Electricity Commissioners envisage the development of rural electrification on the basis of direct or indirect supplies from the main 132,000-volt "grid" system of the Central Electricity Board into a secondary system at 33,000 volts, from which bulk supplies will be taken for the 11,000-volt network of the rural area, with a final transformation to 400/230 volts for distribution to consumers.

To secure economy in capital expenditure, which is the dominant factor in rural electrification, the fullest use must be made of overhead lines, as the substantially higher cost of underground distribution interposes a serious and in many cases an absolute obstacle in the way of development on that basis.

It is also suggested that a comprehensive scheme should always be planned for the development of the area as a whole ; or, in cases where very large rural areas are concerned, for sections preferably of about 100 square miles in extent. The construction of a series of ring mains for the supply of the area is more economical, tends to ensure continuity of supply, and permits of intensive development and the more rapid connection of new consumers in any part of the area, as compared with sporadic and irregular development by extensions and spurs from existing lines, the latter method being slower and more expensive in the end and resulting in earlier limits of development through voltage drop.

In the construction of the overhead system, economy in the cost of conductors can be secured by the use of steel-cored aluminium, copper-cored steel, aluminium-cored steel and ordinary galvanised steel, depending on the current-carrying capacity required ; while further savings can be effected by taking the maximum advantage of the relaxations allowed by the new code of Overhead Line Regulations ; by negotiating or obtaining all wayleaves in advance so that constructional work is not delayed ; and by erecting the complete system or a large section thereof as a single job instead of proceeding piecemeal with small sections at different times.

In order to secure the fullest possible electrification of rural areas with results which will be beneficial to the undertaking and to consumers alike, it is essential that consumers should be offered (*a*) an attractive two-part tariff which will stimulate the use of electricity, particularly for the variety of purposes for which it can be employed on the farm and in domestic premises ; and (*b*) the best possible facilities in the way of assisted wiring and for the hire and/or hire-purchase of electrical fittings and apparatus, so as to overcome the difficulties which the initial costs of wiring and apparatus are otherwise bound to present as deterrents to the wide use of electricity in rural areas. It is important that these facilities should be coupled with an efficient maintenance service.

As a concluding feature, reference is made to the importance of well-directed efforts of educational publicity, of active canvassing and of show-room or other demonstrations of the convenience and utility of electricity for a variety of purposes in connection with the domestic and occupational pursuits of rural communities. Propaganda of an intensive character, to produce the best results, should be undertaken shortly before supplies are likely to be available, and not too long in advance.

THE QUARTER'S SHIPBUILDING RETURNS.

FROM the statistics issued by Lloyd's Register of Shipping regarding vessels under construction at the end of March, we note that in Great Britain and Ireland there was an increase of 54,739 tons in the work in hand as compared with the figures for last December, and that the total, 1,614,993 tons, was 257,618 tons greater than the tonnage which was being built at the end of March, 1929. It may be of interest to state that about 92,000 tons of the tonnage now in hand in this country are intended for the British Dominions, about 295,000 tons for Norway, and about 255,000 tons are for other foreign shipowners or for sale.

The tonnage now under construction abroad, 1,650,936 tons, is 100,310 tons greater than the work which was in hand at the end of December, 1929. Five countries abroad have more than 150,000 tons under construction, viz., Germany, 231,162 tons ; United States, 222,974 tons ; France, 182,930 tons ; Holland, 178,683 tons ; and Japan, 167,055 tons. The total tonnage under construction in the world amounts to 3,265,929 tons, of which 49·4 per cent. is being built in Great Britain and Ireland and 50·6 per cent. abroad. The average percentages in the last twelve months before the war were 57·2 for Great Britain and Ireland and 42·8 for abroad.

In Great Britain and Ireland 426,570 tons were commenced—a decrease of about 72,000 tons over the similar figures for the December quarter ; and 344,699 tons were launched, a decrease of about 128,000 tons. Abroad 430,231 tons were begun and 308,184 tons launched.

A large increase as compared with the previous quarter is shown in the tanker tonnage under construction, the present figures being 122 vessels of 886,884 tons, of which 77 vessels of 558,778 tons are being built in Great Britain and Ireland, and nine vessels of 84,745 tons in Germany. It is of interest to note that of the 122 tankers under construction, 104 are motor ships. The tanker tonnage now being built represents over 27 per cent. of the total steam and motor tonnage under construction in the world.

The tonnage of motor ships under construction in Great Britain and Ireland—876,960 tons—exceeds, for the first time, the tonnage of steamers being built—736,033 tons—while the motor ship tonnage being constructed abroad—1,054,402 tons—is nearly 85 per cent. greater than the tonnage of steamers. The continued progress in the employment of the internal combustion engine for the larger vessels is indicated by the fact that while there are now being built in the world 91 motor ships, each of 8000 tons and upwards, only 30 steamers of such size are under construction.

A Table respecting marine engines shows that the indicated horse-power of steam engines now being built or being fitted on board amounts to about 1,159,000 horse-power, while the figures for oil engines aggregate about 1,560,000 horse-power. The figures for steam engines include sixty-five sets of turbine engines of about 652,000 shaft horse-power, giving an average of 10,000 H.P. per set.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE UNEMPLOYMENT PROBLEM.

SIR,—It is to be hoped that many engineers will respond to the suggestion of Mr. J. E. Tuke and form a group to evolve some common-sense system of finance which will enable the abundance of goods and services it is possible to produce to be consumed. Everything has advanced in efficiency since the war except finance, which appears quite static and incapable of adaption by financiers to modern methods. Listen to Sir Henry Burt, Chairman of the Bengal and North-Western Railway, addressing the annual meeting on January 28th last : "An ambitious programme for new mileage was prepared, estimates were sanctioned and funds allotted. There was to be no further postponement of works once started with its consequent loss. This effort on the part of the Government of India to bring about a much-needed reform expired almost at its birth, and to-day we see a ruthless withdrawal of grants already promised, construction staff dismissed and a stoppage of construction programmes." Why ? All the physical factors were available ; this useful work would have been more effective in neutralising Ghandi-ism than all the half-baked promises of Dominion Status and other political sops, the meaning of which no one really knows. Yet it was not allowed to proceed because an inelastic and hide-bound system of finance vetoed it.

All the material factors exist in this and every industrial country for unprecedented prosperity, but finance lays on them a dead hand, and the peoples of the world totter despairingly towards irremediable catastrophe.

It is up to the engineers to take the matter into their own hands and save civilisation.

Liverpool, April 12th. ARTHUR WILLIAMSON.

B.E.S.A. SPECIFICATIONS.

NICKEL-COPPER (CUPRO-NICKEL) SHEETS AND STRIP AND REFINED NICKEL (GRADE A).

THE British Standard Specifications for non-ferrous metals and alloys have recently been extended by the issue of two specifications relating to nickel. The first, No. 374–1930, "Nickel-copper (Cupro-nickel) Sheets and Strips," standardises sheets and strips of four different chemical compositions. In this specification the physical properties of the material are laid down, tensile and bend tests being prescribed, whilst tolerances on thickness are specified for sheets and strips of various widths and gauges. The second specification, No. 375–1930, "Refined Nickel (Grade A)," provides for a nickel of 99 per cent. purity. The desirability of preparing specifications for other non-ferrous nickel alloys is shortly to receive the attention of the appropriate committee of the Association.

Copies of these two specifications may be obtained from the British Engineering Standards Association, Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each, post free.

BOOKS RECEIVED.

The Royal Air Force Quarterly. Vol. I., No. 2. Aldershot : Gale and Polden, Wellington Works. Price 5s. net.

Transactions of the Institution of Engineers, Australia. Vol. VIII. Sydney, N.S.W.: The Institution of Engineers, Australia, 16, College-street.

Transmission Networks and Wave Filters. By T. E. Shea. London : Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 32s. net.

Economic Conditions in Brazil. Report by S. G. Irving. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

Illinois River Studies, 1925–1928. Bulletin No. 28. By. C. S. Boruff and A. M. Buswell. Illinois : Department of Registration and Education, Urbana.

The Empire Municipal Directory and Year Book, 1930–31. London : *Municipal Engineering*, 8, Breams-buildings, Chancery-lane, E.C. 4. Price 12s. 6d. net.

Theory of Electrical Artificial Lines and Filters. By A. C. Bartlett, B.A. London : Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 13s. 6d. net.

The Analysis of Commercial Lubricating Oils by Physical Methods. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. 9d. net.

Definitions and Formulæ for Students, Marine Engineering. Compiled by E. Wood, B.Sc. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6d. net.

The Jointing of Metals Research, No. 3 : Part I., Soft Solders and Soldered Joints. Birmingham : The British Non-ferrous Metals Research Association, 71, Temple-row. Price 10s. net.

Modern Steelwork : A Review of Current Practice in the Employment of Structural Steelwork in Buildings and Bridges. Edited by W. R. Gilbert. London : The British Steelwork Association, Artillery House, Artillery-row, S.W. 1. Price 5s. net.

The Microscopical Examination of Coal. By C. A. Leyler, B.Sc., assisted by W. J. Edwards. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

A Survey of the Trade in Rubber Manufactured Goods. Fourteenth Report of the Imperial Economic Committee. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 6d. net.

30,000 KILOWATT FREQUENCY CHANGER AT DEPTFORD WEST POWER STATION

THE METROPOLITAN-VICKERS ELECTRICAL CO., LTD., ENGINEERS

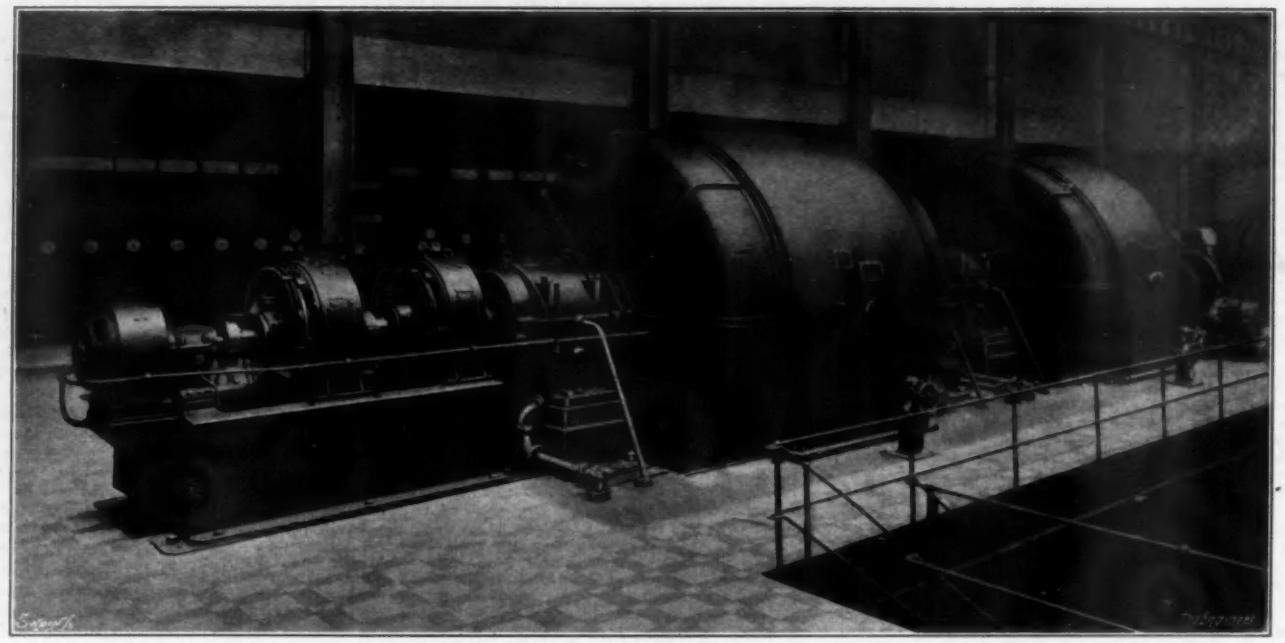


FIG. 1—VIEW SHOWING THE EXCITERS

A 30,000-Kilowatt Frequency Changer.

A 30,000-KILOWATT frequency changer, built by the Metropolitan-Vickers Electrical Company to the specification of Dr. S. L. Pearce, the chief engineer of the London Power Company, has recently been put into service in the Deptford West power station. Considered with regard to its continuous rating, it is by far the largest machine of the kind installed in this country, and is indeed one of the largest frequency changers in the world. Perhaps its most notable feature, however, is its high overload capacity, which exceeds 100,000 kilowatts. The function of the set, which is shown in Figs. 1 and 2, is to couple together the London Power Company's 50-cycle system, comprising the new Deptford West station, together with several older stations, and the company's 25-cycle system of the adjoining Deptford East station, which deals mainly with the varying traction load of the Southern Railway. On the 25-cycle side the total capacity of the plant actually operating in parallel is about 90,000 kilowatts, and about 230,000 kilowatts on the 50-cycle side, but considerable extensions on this side are in progress. It is on account of the magnitude of these capacities and of the possible load variations, especially at times of disturbances, that the high peak load has been called for, and since the requirements of the system demand at different times a transfer of power in both directions, the set is designed for automatic reversible operation.

The two main units of the set are therefore synchronous machines, either of which serves as a motor and the other as a generator, according to the direction of power transfer. Both machines are designed for a normal output of 33,300 kVA at 0·9 power factor. The 25-cycle machine is wound for 11,000 volts, three-phase, which is the pressure of the 25-cycle station bus-bars, whilst the 50-cycle machine is wound for 6600 volts and is connected to the 22,000-volt bus-bars of the new station by means of a bank of step-up transformers. After consideration of the merits of the various possible speeds, *i.e.*, 1500, 750, 500, and 375 revolutions per minute, the speed of 500 revolutions was finally selected as the most suitable from the point of view of general reliability, first cost, floor space, and means of starting. The main machines therefore have six and twelve poles respectively. Both machines have an outside diameter of 13ft. 6in., and the height of the centres is 4ft. 6in. above floor level. The 25-cycle machine weighs 151 tons, the stator weighing 79 tons and the rotor 72 tons, whilst the 50-cycle machine weighs 128 tons, the stator accounting for 55 tons and the rotor 73 tons. Other details, such as the starting motor, barring gear, exciters, bearing pedestals, sole-plates, oiling system, &c., bring the total weight of the set up to 355 tons. The overall length is 64ft.

Whilst the general design of the six-pole rotor is similar to the arrangement adopted by the makers as standard for six-pole, 50-cycle, geared turbo-alternators, synchronous condensers, &c., it embodies modifications necessitated by the exceptional size of the parts. The body of the rotor is composed of cast steel, the poles being integral with the hub, and on account of its great weight it is divided in the middle of its length into two identical sections. The rough casting weight of each of the two parts was 20 tons. The twelve-pole rotor—Fig. 3—has laminated poles, and is provided with a damper winding. Semi-circular cast steel end plates serve for clamping the pole stampings, and the poles and end plates are dovetailed and hydraulically pressed into slots machined in the rotor body without the use of taper keys. The rotor body is a hollow steel casting, but on account of its smaller section as compared with that of the six-pole rotor, it was cast in a single piece with a weight in the rough state of 28 tons.

Both stators are constructed on similar lines, and the welded steel frames have axial and circumferential stiffening ribs. The core stampings, which are composed of silicon alloy steel, are built on axial bolts, which lie outside the magnetic circuit, and are firmly riveted to the axial ribs of the frame. These bolts also serve to clamp the core axially between the complete circular steel end plates to which heavy steel fingers for supporting the stator teeth are welded. The two-layer diamond coils of the stator windings were, as is usual, formed and completely insulated before they were placed in the open type slots, the coil ends being rigidly braced by cording to an insulated steel ring, supported on brackets from the frame and clamped against any movement or deformation. To reduce eddy currents to a minimum, the conductors are laminated, and the order of the laminæ is transposed in the end connections. Figs. 4 and 5 show the six-pole stator before and after winding respectively. The main units are both ventilated on the closed circuit system. Fans mounted at both ends of the rotor provide the air circulation, whilst the air is cooled by means of water-cooling elements built into the foundation block. In the air ducts there are dampers which can stop the circulation of air in the event of fire.

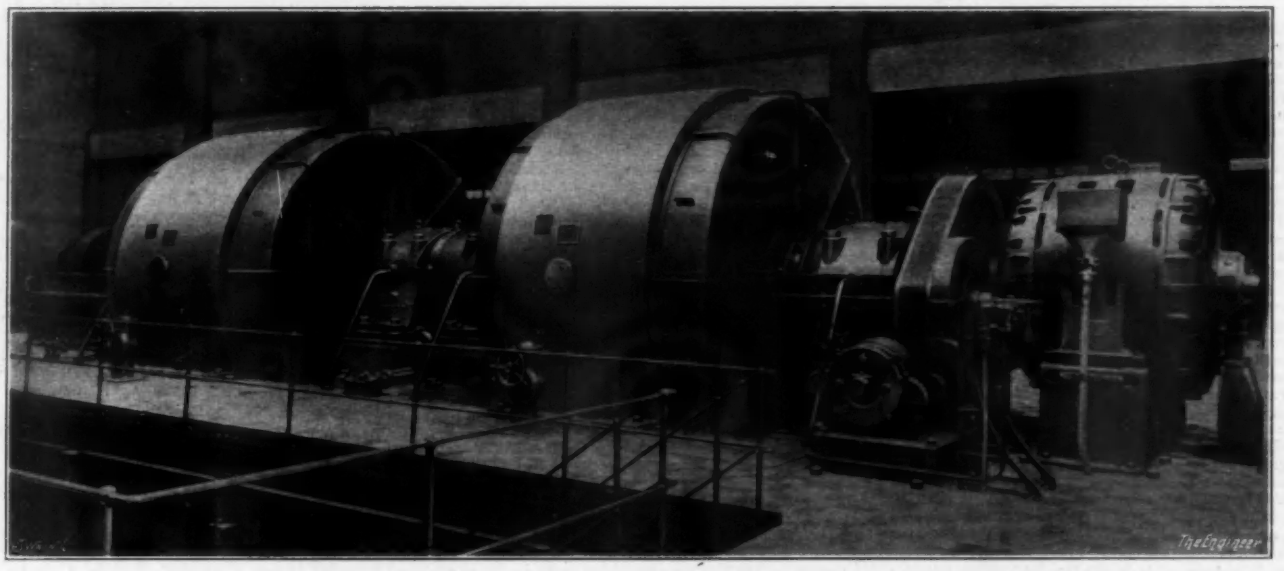


FIG. 2—30,000-kW FREQUENCY CHANGER, SHOWING STARTING MOTOR AND BARRING GEAR

There are four main bearings, each 24in. in diameter and 36in. long, all lubricated by low-pressure oil circulation, provided by duplicate motor-driven centrifugal pumps, with coolers, in the basement. In the event of the pump in service failing contactor gear automatically starts the other pump.

A 6600-volt, ten-pole, slip-ring induction motor, supplied through a separate transformer from the 50-cycle bus-bars, serves for starting the frequency changer. The rotor of this motor is overhung on an extension of the main shaft at the 50-cycle end of the machine, and its starting resistances, which are placed in the basement, are controlled automatically by contactor gear with current-limiting relays. On closing the starting motor circuit breaker by means of a push-button in the control room, where the speed is indicated by an electrical tachometer driven from the extreme end of the starting motor shaft, the set is started and accelerated to full speed. The last step of the rotor resistance causes the set to run slightly above normal speed. At that point one of the main machines is excited, so that it gives its normal voltage, and the speed is finally adjusted for the purpose of synchronising by partially exciting the other machine. For that purpose a small auxiliary rheostat in the field circuit of the 25-cycle machine is installed in the 50-cycle control room.

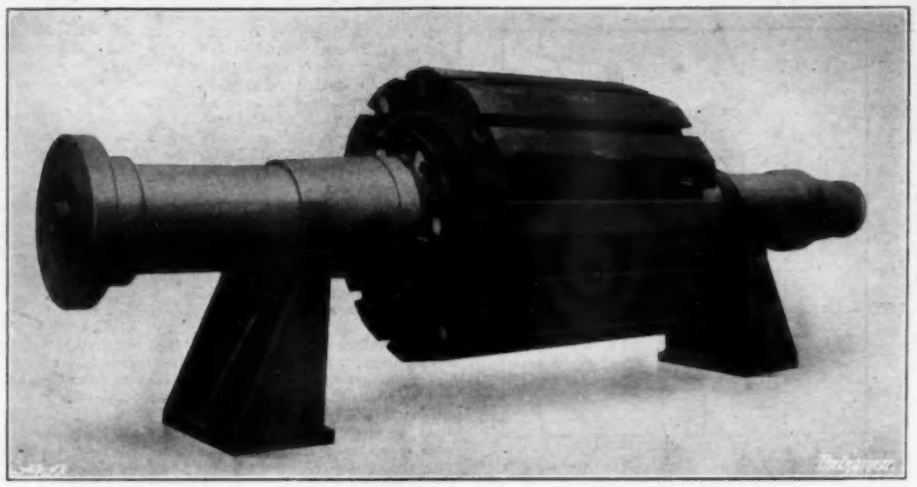


FIG. 3—12-POLE ROTOR

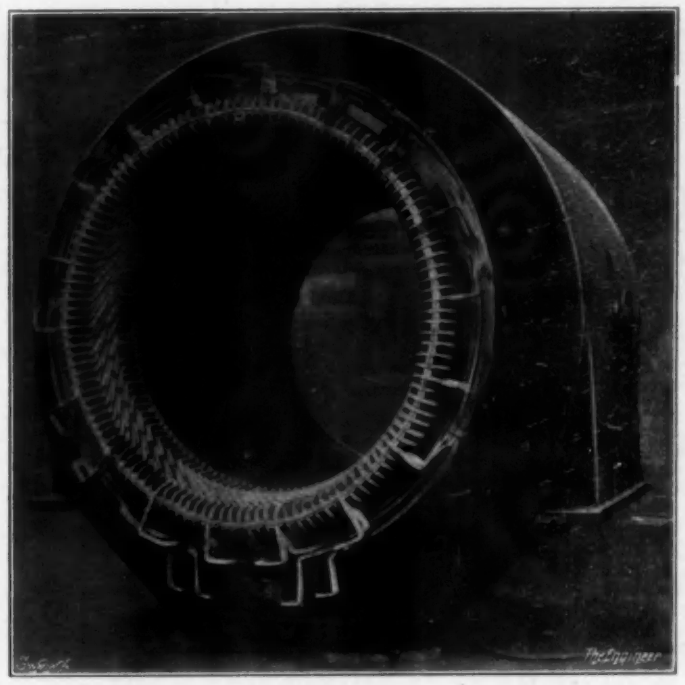
To relieve the bearing friction at starting, oil is injected under the main journals at high pressure by four separate motor-driven pumps mounted alongside the bearing pedestals. For the purpose of inspection, motor-driven barring gear at the 50-cycle end of the machine provides a means of turning the set at a speed of one revolution per minute. This can be used as alternative to the high-pressure starting lubrication, and when so used it is automatically thrown out of engagement as the set is accelerated by the starting motor. The excitation of the set and its automatic control are carried out on a novel system, developed by the Metropolitan-Vickers Electrical Company to meet the particular requirements of frequency changer service. A frequency changer interconnecting two large power systems must remain in synchronism on both sides under all conditions of load consistent with the mechanical security of its main shaft, and the safe temperature limits of the windings must not be exceeded. To ensure that these conditions are met, it is essential for the excitation of both machines to bear a direct relation to the kilowatt load on the set, whilst, since during disturbances of the system the machine may be called upon to carry temporary loads far in excess of its normal rating and rapid variations of load, a quick-response super-excitation system is requisite. The field currents of the main machines are supplied by two identical exciters designed for rapid build up and a high maximum voltage. These exciters are coupled to the main shaft at the 25-cycle end and, as shown in Fig. 1, have a single outboard bearing. The small machine at the extreme end of the set provides the field current of these exciters and works at a fixed voltage.

For each machine a quick-acting automatic regulator of the Metropolitan-Vickers vibrating type is provided, and the control coils are energised by both voltage and current windings. Over the normal range of load the regulator acts only as a small part of the total resistance in the main exciter field. At about 25 per cent. overload the limit of this control is reached, and with further increase of load the power factor rises, reaching unity at about 80 per cent. overload, or 54,000 kW. If further increase of load occurs, or if the rise of load has been so rapid that the normal excitation has been unable to follow it closely, then the regulator operates through quick-acting contactors to cut out a large resistance from the exciter field, thus causing a very rapid rise of the exciter voltage towards a maximum of 2½ times normal. The main field current rises rapidly until limited by current relays at 1·75 times normal full load excitation. With this super-excitation the set can maintain 0·9 power factor with 2½ times full load, or 75,000 kW., and it will reach unity power factor with a load of 3·3 times full load, or 100,000 kW., and it will not fall out of step on either side with a load of less than 105,000 kW. As the plant was designed for a very conservative temperature rise on normal load, and in view of the high-grade insulation that is used in modern machines of this size, it has a large capacity for sustained overloads, and to take full advantage of this reserve capacity both machines are protected by overload relays of the thermal type, designed to have a rate of heating similar to that of the main windings. The set is thus permitted to carry twice full load for half an hour, or 100,000 kW for 5 minutes, starting from normal full load temperature, but in practice the instantaneous overload relays only operate at 90,000 kW.

FIG. 6—GAUGE BOARD

An elaborate gauge board—see Fig. 6—designed on similar lines to that for turbo-alternator sets, is fitted with distant indicating thermometers for the inlet and outlet air temperatures and for the oil temperatures of the main bearings, thermo-couple indicators showing the temperature of the stator windings and at various points in the air and oil-cooling equipment, and alarm signal apparatus, which operates in the event of excess air or bearing temperatures or interruption of the oil circulation to the main bearings. Visual and audible signals are provided, together with switching arrangements, so that the latter can be put out of action while the defect is being remedied. On the gauge board tere areh also push-buttons for tripping the starting motor switch, or, in the case of emergency, the two main switches.

On account of its length the complete set was not



FIGS. 4 AND 5—STATOR FOR 6-POLE ROTOR MACHINE, BEFORE AND AFTER WINDING

assembled at the works, but each machine was fully tested separately. The separate losses were measured by means of a direct-coupled, direct-current driving motor, and the results showed an overall efficiency for the complete set working at 0·9 power factor, including excitation and all stray losses, of 94·7 per cent. at full load, 94·35 per cent. at 80 per cent. load, 93·5 per cent. at 60 per cent. load, and 91·4 per cent. at 40 per cent. load.

On both machines separate open circuit and short circuit heating tests were carried out, and the results showed that the machines complied with the guaranteed temperature rise of 65 deg. Cent., measured by increase of resistance on the stator and rotor at normal load. The starting motor and barring gear were assembled with the 50-cycle machine and the operation of the starting equipment was fully tested, whilst the complete exciter was assembled with the 25-cycle machine, thus enabling the operation of the automatic regulator and super-excitation equipment to be demonstrated.

Some Materials Used for Naval Engineering Purposes.*

By Engineer-Captain J. HOPE HARRISON, R.N.

In this paper the behaviour on service of some materials that have been employed for machinery purposes in the naval service since the war is summarised.

The reintroduction into the naval service of superheated steam involved a search for materials that would give good service in contact with steam at higher temperatures than had previously ruled, and the increased adoption of heavy oil engines, both for propelling and auxiliary purposes, and the investigation of suitable materials for them has caused the claims of a large variety of different metals and alloys to be exhaustively studied.

Had the Commander-in-Chief of the Grand Fleet, towards the end of the war, been asked what two parts of his propelling machinery caused him most anxiety, he would probably have replied "condensers and boilers." Materials of which boilers and condensers and their attendant parts are constructed may still be said to require more attention than other parts of a warship's propelling machinery, although recently the increase of temperatures has added a third—turbines. Turbine defects have, however, been mostly confined to blading and nozzle vanes.

Boilers.—During the last ten years experience in H.M. Navy has been almost exclusively with water-tube boilers, and steam is now generated by oil fuel in almost every fighting ship.

Brickwork.—The material that has to be more frequently renewed than any other is brickwork. The weight of brickwork in a boiler is one-sixth to one-eighth of the total weight of the complete boiler. Brick defects are not usually serious. They can be made good while the periodical cleaning is being carried out, but should serious defects occur when steaming, speed must be reduced. Boiler bricks and bonding material should not fuse below 3000 deg. Fah.

Some trouble has been experienced with "bonding" material, but a good fire-clay, fusing temperature not less than 3000 deg. Fah., well mixed with crushed fire-brick in the proportion 1 : 1, has given satisfactory service. Taking the average annual bill for fire-bricks and fire-clay, and dividing this by the cost of brickwork in one boiler, it is shown that on the average each water-tube boiler has to have the brickwork completely renewed every three years. There is an urgent need for a lighter and more refractory fire-brick.

Boiler Tubes.—After brickwork the most important parts of a water-tube boiler that develop defects are the tubes. Since 1919, 2100 boilers have been examined for wear and waste by, amongst other methods, removing sample tubes and cutting them longitudinally. Defects necessitating the retubing of boilers have been mainly :—(1) Internal corrosion : 90 per cent. of the renewals are due to this cause ; (2) external corrosion : 9 per cent. renewed for this reason ; (3) distortion of tubes ; (4) cracking of tubes or tube plates.

Until recently all Admiralty tubes were manufactured from "blown" or "wild" steel ingots, but within the last few years tubes have been made from what has been called "non-segregated" steel. For many years this was considered to be commercially impracticable, but the tubes from this steel have a finish equal to tubes from "wild" ingots. The tubes from "non-segregated" steel have not been in service long enough yet to enable a comparison to be made, but there is abundant evidence that defects due to internal corrosion are less liable to occur if tubes are made of steel containing as few "inclusions" as possible. It appears to be doubtful whether the blow-holes in "wild" ingots weld satisfactorily, and even if they do there is evidence that the "inclusions" in the steel where the blow-holes have existed sometimes lead to rapid corrosion.

An examination of a large number of sulphur prints taken from billets from which tubes have been drawn shows that the "inclusions" are very unevenly distributed in "wild" steel.

Examination of a section of a billet shows that the outer space may contain as little as 0·05 per cent. of carbon, although the average carbon content is 0·10 per cent. to 0·15 per cent.

Boiler tubes for naval boilers of the small-tube type are made from 0·116in. to 0·156in. thick, but the maximum is now usually 0·128in. The thicker and larger tubes are used for fire rows. The thickness is arrived at by calculating the total stress to which the tube is subjected by heat and fluid pressure, and by experience.

This calculation shows that the total stress is about 3·1 tons per square inch for a tube 0·05in. thick and 1¾in. diameter, working at a pressure of 250 lb. per square inch when the heat transmitted per square foot surface per second equals 30 B.Th.U.

In Fig. 1 curves are shown indicating the fluid, heat, and combined stresses in a fire row tube 1¾in. external diameter and of varying thickness when passing heat at the rate of 30 B.Th.U. per square foot per second at a working pressure of boiler 250 lb. per square inch. From this diagram it is seen that the ideal theoretical wall thickness is about 0·08in. for the conditions stated. Experience has shown in past years that boilers require retubing once during a life, of, say, twenty years.

A word should be said about tube expanding or rolling. Only two or three turns of the expander should be given after the tube is bearing on the plate. The danger of over-rolling cannot be too strongly emphasised. Excessive rolling overstrains the tube material and makes it more susceptible to corrosion, at the point where corrosion is

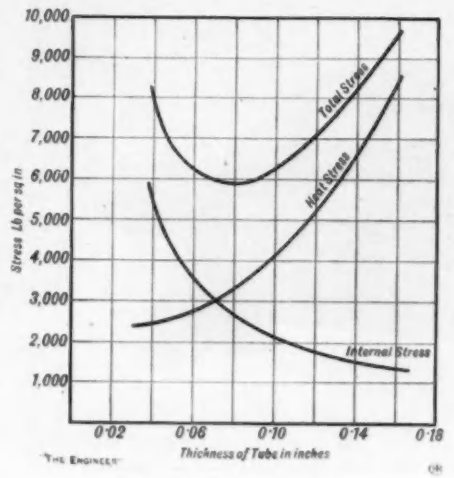


FIG. 1—STRESS CURVES

most objectionable. Many examples have been found of patches of internal corrosion limited to the area of tube that has been rolled. Over-rolling makes the tube plate brittle and cracks between tube plate holes are occasionally discovered, undoubtedly due to over-rolling. It is quite possible that tube distortion has been caused by irregular and severe rolling, although direct evidence of this is lacking.

Sample superheater tubes taken from H.M.S. "Rodney" and "Nelson" were recently examined. These ships have been in commission since 1927. After cutting they were found to be in excellent condition. The steel from which these tubes were manufactured contained the normal 0·1–0·15 per cent. C and was in other respects the same as that generally used for boiler tubes. No reason is seen at present to fear that superheater tubes will have to be renewed before the generator tubes.

For some years in America a low-carbon steel containing a small percentage of copper has been popular. The qualities claimed include a high resistance to corrosion. A shore boiler has been partially retubed with this material and other experiments are in progress, but it is too early to make a statement about it. It should be stated that the general opinion appears to be that such a steel will show little superior power to resist corrosion over that now in use.

Heat-resisting Steels.—Materials subjected to stress at high temperatures, *i.e.*, over 1000 deg. Fah., have been used in boilers for supporting superheater tubes. Among others the following materials have been used and reports have been received stating that on close examination they are in a satisfactory condition. There is no evidence of twisting, burning or corrosion. The following are the percentages of the constituents :—(1) Cronite : 0·6–0·7 carbon, 1·0 manganese, 14·0 chromium, 60·0 nickel ; (2) ERA : 0·2–0·3 carbon, 3·0 manganese, 80·0 chromium, 6·5 nickel ; (3) Wiggins metal : 20·0 chromium, 80·0 nickel.

Samples of materials proposed by contractors, the behaviour of which at high temperatures is not known, have to be forwarded to the Admiralty for test before permission is given to incorporate them in naval machinery. When it has been necessary to know the limiting creep stress of a material at a certain temperature the aid of the National Physical Laboratory has been requested, but Mr. Tapsell, who has conducted this research, is of the opinion that four to five months are required to obtain a satisfactory value of limiting creep stress at one temperature.

Dr. Hatfield stated in the Edward de Mille Campbell Memorial Lecture, on October 10th, 1928, that he had heard the view expressed that an engineer would be in a position to design adequately, with resultant suitable factors of safety, if he was in possession of the data concerning the stresses below which the rate of creep would not exceed 0·000001 per inch per hour. It is not considered that the opinion of a layman is conclusive as to the time or method to be employed to determine limiting creep stress, but from an engineer's point of view it is desirable that at least a close approximation should be obtained as quickly as possible. If the limiting creep stress can be obtained to within 0·25 ton per square inch this should be an approximation sufficiently near. It has not been the usual custom of designers, in the past, to stress a material to a point too near the "yield."

Condensers and Condenser Tubes.—In 1920 Engineer Lieutenant-Commander G. B. Allen, R.N., read a paper before the Institute of Metals on "Service Experience with Condensers." Speaking of condenser tubes, he summed up the situation as follows :—"With every precaution taken during manufacture and with the adoption of any known preventative or protective process, it must be admitted that freedom from deterioration cannot be guaranteed ; and it appears that complete immunity, or at least a guaranteed life, can only be obtained by the employment of an alloy other than a simple brass."

A considerable amount of further research work has been carried out since the date of that paper, and although the subject is undoubtedly better understood, it cannot be said that condenser troubles are now a thing of the past. Since 1918 the reports made to the Admiralty of cases of failure of condenser tubes show an average of fifty per annum, assuming that each defect reported counts as one, although several tubes may be referred to.

In Fig. 2 the more common types of condensers fitted are given, and a table showing the total failures per annum with all types since 1918 follows. By far the largest percentages of failures have occurred on foreign stations, and making allowances for the numbers of ships on each station, the highest percentages of failures have been reported from the West Indian, China, and African stations, showing undoubtedly that sea water temperature is an active factor.

The failures reported show that the design of the condenser is important. Type E, Fig. 2, appears to be the best. It should be stated that the tube surface per horse-power is approximately the same in all cases. Defects have occurred at all positions of the tubes ; but principally as indicated by shading in the sketches. It should be observed that in Type A condenser the large number of

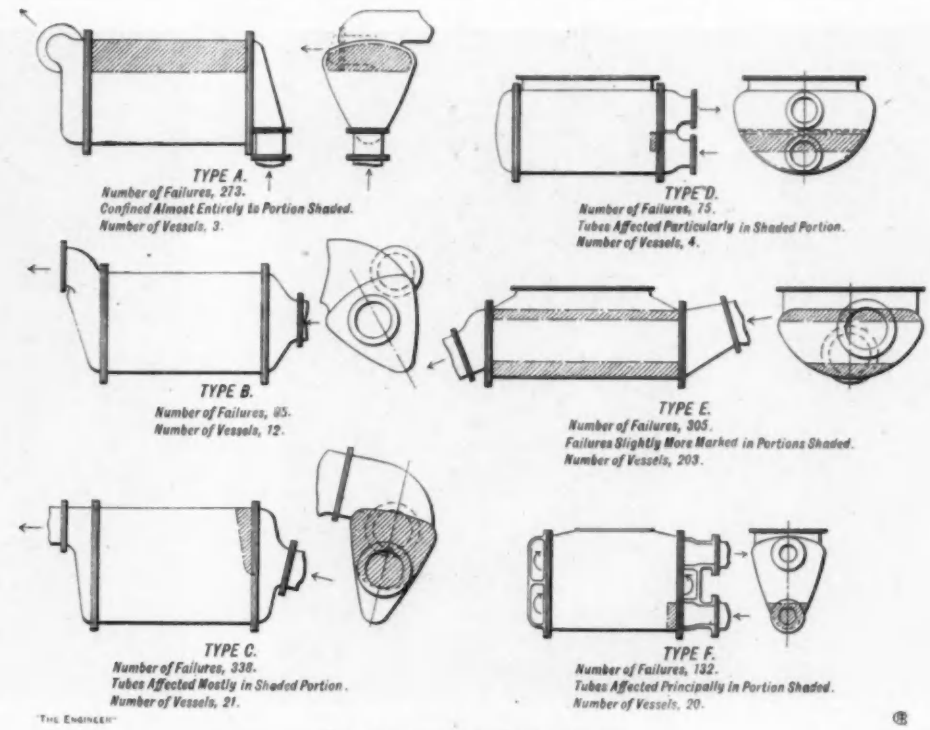


FIG. 2—TYPES OF CONDENSERS

Failures Reported in Condensers.

Year.	No. of failures reported.	Year.	No. of failures reported.
1918	51	1924	37
1919	53	1925	38
1920	48	1926	45
1921	43	1927	45
1922	72	1928	60
1923	39	1929	48

* Institution of Naval Architects, April 9th, 1930. Slightly abridged.

defects reported are probably due to the use of wartime material, which, beside being of lower grade, did not have such rigorous inspection as is now possible and necessary.

To enable readers to realise the nature and type of defects reported, the exact figures for 1926–27 have been analysed, and are as follows:—Total tubes in all condensers, 2,892,400; total tube failures reported, 157. Causes: End action corrosion at inlet end, 29·4 per cent.; local pitting, 19·8 per cent.; obstruction, 3·2 per cent.; steam impingement, 10·8 per cent.; external damage to tubes, 2·5 per cent.; crushed ends, 2·5 per cent.; splitting, 6·4 per cent.; general corrosion, 19·7 per cent.; insufficient information reported to assess causes, 5·7 per cent.; total 100·0 per cent.

Only twelve failures were reported from warships operating in home waters.

The actual ratio of failures to total tubes fitted is small, but one tube failure out of nearly 60,000 tubes fitted may put one ship out of action for a time. Practically all the failures reported have been of tubes manufactured from Admiralty brass, the specified composition of which metal is—copper, 70 per cent.; tin, 1 per cent. minimum; zinc, remainder.

A number of alloys have been manufactured into condenser tubes, and coated brass tubes have also been fitted, but, until extensive experience on service has been gained, it has now been decided that a mixture containing 70 per cent. copper and 30 per cent. nickel or monel shall be used.

Difficulty was experienced at first in obtaining tubes of other material than Admiralty mixture, with the high standard of finish that had been obtained. Manufacturers have now succeeded in producing tubes of copper nickel, the finish of which is equal to any previously obtained.

Materials that have been tried or are now under trial are:—(1) Stainless steel; (2) Staybrite steel; (3) monel; (4) aluminium brass; (5) melloid; (6) chromium coated, 0·0005 to 0·001 of 1in. of chromium on Admiralty brass tubes; (7) corronil; (8) synthetic monel; (9) copper nickel, 80–20; (10) copper nickel, 70–30; (11) brass, Admiralty mixture; and (12) silveroid.

The only tubes that have stood up on service without showing signs of corrosion at all, up to the present, are Nos. 4, 10, and 12. Care must be exercised in speaking of trials of condenser tubes as cases are known of Admiralty brass tubes that have shown no signs of deterioration for over twelve years, and with the exception of No. 11 none of the above has been fitted in ships for much longer than five years.

No. 6 has only just completed one year's trial, and the coating has been found to be removed in places. No. 4 has not been in use long enough or in sufficiently varying types of ships to assume that it will give good service under all conditions. Solid packing in lieu of linen gromets has been tried with success.

Originally condenser doors were of gun-metal, but were replaced by cast iron with a view to resisting tube corrosion. Recently cast iron end doors and water boxes have been replaced by cast and mild steel.

Cast steel doors are necessarily thick, and there is a fair margin of strength. With a view to reduction of weight, while retaining strength and a measure of resilience, doors were built up of boiler plates and angles. Corrosion proved rapid on built-up doors on service, and as the doors were only $\frac{3}{4}$in. to $\frac{1}{4}$in. thick, some form of protective coating was found to be necessary. Rubber was first tried but peeled off the outlet end. Doors were recoated and then vulcanised. This was done by clamping two doors together and filling with steam.

The rubber coat may be either hard or soft. Hard rubber is liable to crack, but resists the action of oil. The results reported to date appear to warrant the experiment being continued, and several processes of "rubbering" doors are now under trial in different ships of the Fleet.

Turbines and Turbine Blading.—Impulse blades of non-ferrous alloys have been badly eroded, but alloy steels having a yield of 25 to 30 tons per square inch have shown no signs of erosion, although defects have developed due to shrouding and broken blades.

The fracture of steel blades has resulted in a careful examination of the material without evidence being discovered that the material has been faulty. No signs of cracks or flaws have been detected, still the possibility of blades being built into a turbine in which there are incipient cracks has led to inspection methods being devised to prevent defective material being used. So far, the Admiralty have not specified that any particular inspection, such as the magnetic, shall be adopted, although it is considered that should steel blades be increasingly employed, and the material now used be accepted as standard, more stringent inspection will have to be adopted.

Impulse blading is now almost exclusively made of the combined type. The Admiralty specify that the blading and shrouding are to be of the same material, but recent experience has in some cases shown that the shrouding strips crack at the holes when riveted, and in consequence a steel of the same composition as the blades, except that the carbon content is lower, has been allowed for the shrouding. The holes in the shrouding are now drilled. It has been thought that steel blade failures have been due to lack of shrouding support since there is invariably some vibration; cases have been reported of blades fracturing where the shrouding is cut to allow for expansion.

Several arrangements have been tried in order to provide continuous support all round the blades, while still allowing for expansion of the shrouding. A number of cases have been reported of impulse blading shrouding working loose, due to excessive vibration or defective workmanship in riveting the blades to the shrouding. When such defects have been detected in time, an efficient repair has been effected by re-riveting the blades. The material of which the blades have been manufactured has shown no signs of deterioration by so re-riveting. The properties of a number of alloys have been examined in order to obtain a material not soft enough to erode, yet sufficiently resilient to withstand any vibration to which it may be subjected. At present, the Admiralty specify that certain turbine stages must have blades of A.T.V. or other approved material. A list of materials recently used for turbine blading is given below.

Phosphor bronze, manganese copper, and brass blading were formerly tested for tensile strength by forming test pieces from the finished blading sections. It is now specified that tests should be taken from the material before it is drawn, as it was found to be difficult to obtain test pieces from certain sections that would indicate the quality of the finished blade. Precautions are necessary to ensure that only electrolytic copper is used for the above, and that the zinc for brass is 99·75 per cent. pure zinc. It appears to be desirable to consider a hardness test for blades in order to avoid defects due to improper final drawing. The last passes should be of limited severity in order to avoid excessive hardness at the edges, which

Turbine Blades.

Nature of Material.	Stage in which used.
Monel	H.P. and astern
Hadfield's A.T.V.	H.P. and astern
Firth's F.G.	H.P., L.P., and astern
Firth's F.M.	H.P., cruising, and astern
Firth's stainless	Astern
Phosphor bronze	In all stages
Brass	All reaction

eventually results in cracks. Brass blading has to be annealed at an approved temperature.

For impulse turbines, nozzle vanes of 3½ per cent. nickel steel have been reported defective.

In addition to the vanes corroding and eroding on service, difficulty has been experienced in casting the vanes in the boxes. A list of materials used for nozzles is given below.

Nozzle control valves of stainless steel have not been entirely satisfactory. Valve pintles have seized in the guides, and valve spindles have seized in the backs of the valves and corroded at the glands. It appears to be advisable to use different metals for valves and seats.

Nozzle Vanes.

Firth's F.M.
Hadfield's A.T.V. in cast iron boxes
Hadfield's A.T.V. in phosphor bronze boxes
Hadfield's A.T.V. nickel plated and cast in phosphor bronze boxes
Firth's Staybrite
Nickel steel
Copper for astern turbines
Gun-metal for astern turbines

Heavy-oil Engines.—Some of the materials used in heavy-oil engines are as follows:—(1) Castings, steel; (2) pistons, "Y" alloy; (3) piston rings, cast iron, B.E.S.A. specification; (4) valves, steel "Quickstep" or E.R.A.; (5) liners, steel; (6) jackets, Staybrite, mild steel; (7) crank shafts, steel.

(1) and (2) will be referred to later.

The experience with (3) and (5) has led to an investigation which has indicated that if excessive wear of (3) is to be avoided the following points require careful attention:—(*a*) Clearance between ring and bottom of groove; (*b*) side clearance of ring groove; (*c*) accuracy of fitting of ring in groove; (*d*) the finish of (5).

As regards (4) it has been found possible, as a result of trials, to replace water-cooled valves by uncooled valves of the materials shown up to certain powers. Trials lasting 1500 hours on service showed that uncooled valves of E.R.A. and Quickstep gave as good service as cooled valves. There is little to choose between the two steels. Some trouble has been experienced with Staybrite jackets, and those originally fitted are being replaced by mild steel. In the design at present the sheet steel from which the jackets are made is welded, and so far we do not appear to have a suitable material. Rapid corrosion on the cooling water side has necessitated frequent renewals. Crank shafts are manufactured from a mild steel 28–32 tons U.T.S.—ultimate tensile stress.

All cranks are forged to their correct angles and not twisted.

Steel Castings.—A considerable amount of research work has been undertaken to investigate the causes of failures in steel castings. Admiralty experience in recent years has been that the defects which have resulted in the rejection of steel catsings are as follows:—(1) Blow-holes; (2) "draws," "pulls," "tears," "hot-tears," generally at flanges or changes of section; (3) porosity under pressure tests; (4) contraction cracks; (5) sand inclusions; (6) scabbing; (7) failure on physical tests.

The majority of the troubles have been either (1), (2), or (3). The application of X-ray examination has been particularly helpful and has revealed defects that otherwise could not be ascertained without destroying the casting.

Admiralty specifications state that approval is to be obtained before contractions or defects in steel castings are repaired by welding. Castings subjected to stress may only be welded when it is necessary for producing sound jointing surfaces, and where no loss of strength is involved. The application of X-ray examination has led to the distrust of the patching of surface defects, since it has revealed the fact that such defects are frequently of a more deep-seated nature than visual examination indicates. X-ray examination at present cannot be said to have arrived at the state when radiographs can in all cases be correctly interpreted, but the results of the work now being carried out at Woolwich for the Admiralty appear to promise that in the near future this method will be increasingly used. The number of firms in England from whom it can be confidently expected a large intricate steel casting can be obtained that will be in every way satisfactory is not large, but it is considered that they can be relied upon to produce castings that are as good as, if not superior to, any that can be produced on the Continent or in America.

Steel Forgings.—The list of alloy steels used for special purposes is a long one and grows longer each year.

Stainless steels for turbine blades and stop valves, and heat-resisting steels for boilers and valves are mentioned elsewhere.

Important alloy steels have been used having an U.T.S. up to 70 tons per square inch. The addition of small amounts of molybdenum and/or tungsten has given materials having excellent qualities, but the difficulties of manufacturing in the masses required, and the variations on test have compelled the general adoption of such materials, except for small parts to be cautiously attempted. Indeed, at the moment, the distrust of very high tensile alloy steels on account of the lack of homogeneity of these alloys has almost resulted in a return to a low carbon steel, even at the expense of greatly increased weight.

A steel having a U.T.S. of 34–38 tons per square inch has been used for propeller shafting, enabling a saving of an average of 7–10 per cent. in weight to be effected over the previously used 28–32-ton steel. Steel liners are now used for heavy-oil engines, containing 0·7 per cent. to 0·75 per cent. C and 0·4 to 0·8 per cent. Mn. For special forgings sulphur prints are required. Izod tests are required, and in some cases a Brinell hardness is specified. In cases of doubtful material, and where cracks or "inclusions" are suspected, macro-prints and micro-photographs are taken. Before work is commenced on important forgings, it is specified that the proposed method of working down from the ingot is to be submitted for approval. This is to ensure that the correct top and bottom discards will be removed at the proper stage, and that the material will be gradually and uniformly forged, in order that the sectional area of the finished forging bears a certain ratio to that of the ingot. Ingots may be hammered, pressed, or rolled, the latter only if the overseer is satisfied that the dimensions are such that the material is sufficiently worked in all directions.

Thermal History Charts.—For important forgings it is now specified that charts are to be provided showing a time-temperature curve covering the whole period between the casting of the ingot and the final machining of the forging.

The ultimate aim in specifying thermal history charts is the steady accumulation of facts, such as these charts afford. It is hoped it will shortly be possible, from a study of a large number of thermal history charts supplied by different makers, to say with some degree of precision how a forging of given dimensions and composition should be forged, or at least whether the heating, forging, cooling and subsequent normalising, annealing and/or other treatment it has been subjected to are likely to have had any injurious effects that will render defects liable to develop on service. The charts supplied by firms already show that the practice in different forges in Britain to-day varies considerably. So far, it cannot be said that a satisfactory stainless steel has given good service in contact with packing and sea water.

Cast Iron.—The Admiralty specification for cast irons has recently been revised and brought into line with current practice. The valuable assistance of the British Cast Iron Research Association has been freely given in revising this specification, and thanks are due to that Association for the help given.

The revision has resulted in a higher U.T.S. being specified for the best class cast iron, and the test pieces are now made and tested on the lines of the latest B.E.S.A. specification for this material Experience has been obtained at dockyards with cast iron for repairs containing a percentage of nickel and satisfactory results have been achieved. The addition of nickel, apart from any additional strength it may add, appears to give a more uniform structure to cast iron, even when added to castings having varying and fairly thick sections, and also improves the quality generally. The comparative absence of flaws and blow-holes is attributed to the addition of small quantities of this material.

Aluminium.—Ten years ago light alloys were practically unused for the machinery of warships apart from C.M.B.s, &c., but to-day tons of light alloys are used in a cruiser. Admiralty policy is that any composition that can be shown to have given good service is tried, and contractors have been encouraged to put forward proposals for the use of aluminium alloys. A saving in weight has been effected in consequence. Amongst the uses to which aluminium alloys not highly stressed have been put are hand wheels and small fittings generally, that although singly not important, are so numerous that the saving of even a small percentage of weight per item makes the total considerable. Modified alloys containing 10–13 per cent. silicon have given good service, and have been used for pump barrels. Over a dozen different compositions have been utilised for various purposes.

One aluminium alloy that has given eminently satisfactory results on the whole for oil engine pistons is the well-known "Y." The original chemical composition has been practically retained, but improvements have been made in the treatment. An U.T.S. of 18 tons per square inch, with 2 per cent. elongation on 2in., has been specified and can be commercially obtained. An actual test reported recently gave 22 tons per square inch, with an elongation of 12 per cent., but, of course, this was exceptional. The defect which aluminium alloys have of corroding rapidly when in contact with sea water has limited the use of this material on ships. Apart from alloys that have been treated in some manner—such as by the anodic process—the "Y" and some modified silicon aluminium alloys have resisted corrosion better than any others.

The liquid in which a material is quenched when heat treated, and the correct ratio of the volume of liquid to the casting, has been the subject of investigation.

The results with different liquids are similar when the oil is new, but the cost initially and cost of renewal is important to the manufacturer. Some oils deteriorate much more rapidly than others, and in consequence results vary. Quenching oils used have been lanoline, torp oil, olive, and rape.

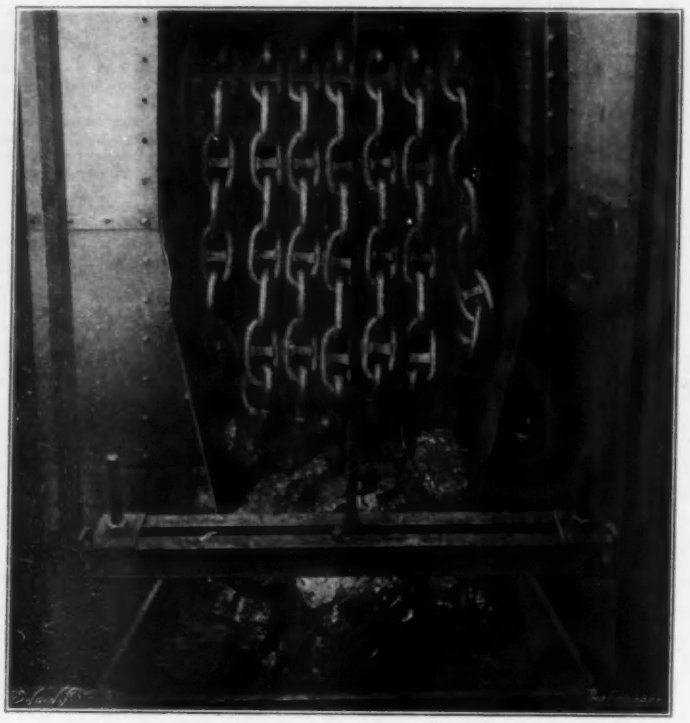
Bolts.—Steel bolts for securing pressure parts have failed in a large number of instances. Sound bolts removed after some service have been found to have an Izod as low as 1½ foot-pounds. There is no direct evidence that the material from which the bolts were manufactured did not pass the specified tests, and there is evidence to show that there has been deterioration in service. Orders have been issued that bolts are to be examined periodically and a percentage withdrawn and tested. It appears to be desirable that more attention should be paid to the material from which bolts are made if they secure important pressure parts. The material from which bolts for highly stressed parts of heavy-oil engines are made is specified to be of 3½ per cent. nickel steel. A heat-treated bolt known as "Hitensile" has been used for sizes up to $\frac{3}{4}$in. diameter, and it is anticipated that this material will give satisfactory service.

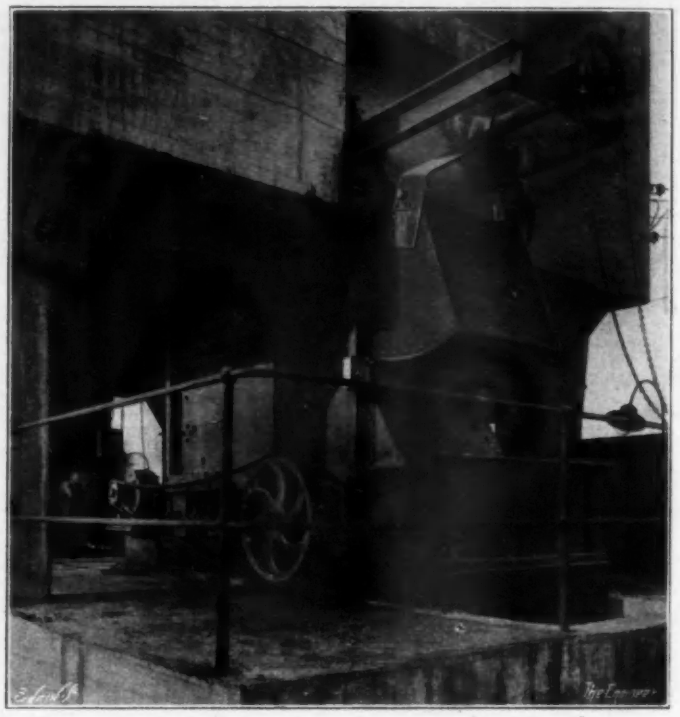
It is the intention of the Admiralty to adopt the B.E.S.A. standard dimensions for bolt heads and nuts. Non-ferrous bolts in contact with sea water should contain not less than 1 per cent. Sn and not more than 1 per cent. Fe, and should be of rolled or forged material.

Brasses and Bronzes.—Amongst the large variety of non-ferrous alloys used for naval purposes, the high-tensile brass used for propellers has given satisfactory service generally. The research work on rolled or forged non-ferrous alloys has resulted in materials eminently suit-

LOCOMOTIVE COALING PLANT AT KIPPS, SCOTLAND

HENRY LEES AND CO., LTD., GLASGOW, ENGINEERS





able, when properly manufactured, for the purposes for which they are used, some having an elongation of 18 per cent., with an U.T.S. of over 40 tons per square inch.

P.M.G. Metal.—A copper silicon alloy, known as P.M.G., containing 3 to 4 per cent. of silicon, has been put forward as a substitute for Admiralty gun-metal. The properties of a number of copper silicon alloys have been investigated recently, and experience with the above has shown that excellent castings can be made of it, and it has a higher U.T.S. at 400 deg. Fah. than gun-metal. This material in the forged or rolled state has shown a high U.T.S. and yield. The behaviour of this alloy on service is being noted. Investigations so far carried out do not warrant the wholesale substitution of P.M.G. for gun-metal for parts subjected to fluid pressure or exposed to the action of sea water, but should the claims made for it be substantiated, the use of it may result in a saving in both price and weight.

Fescolising.—Considerable experience has been obtained of this process, which is now well known, by which metal can be built up without the application of heat. This electro-chemical deposition has been used by the Admiralty to coat condenser tubes, working parts of steam pipes in expansion glands, steam valves subjected to superheated steam, damaged rotor shafts, damaged turbine wheels, surfaces working through glands in contact with water. The metal deposited, generally nickel, has been found to adhere well to the surface on which it has been deposited, when carefully and skilfully applied, and the application of this process for new work and repairs is now considered to be beyond the experimental stage for certain special cases.

Tests undertaken by the National Physical Laboratory have shown that the resistance to shear of a thick ring of nickel deposited round a steel shaft is practically that of the metal itself, so close is the adhesion. The trials of nickel deposits on steam valves and seats for superheated steam have not given entire satisfaction, owing to the deposits not being of sufficient thickness to allow for grinding should the faces be cut by extraneous matter carried through by the steam. A valve and seat are still in use that have given satisfaction for over a year, though there is evidence that it is not desirable to arrange for two parts on which nickel has been deposited to enage each other, as, for instance, a valve guide and a valve pintle.

Lagging Material.—The temperature that lagging is to withstand without in any way deteriorating has been recently raised in view of the employment of superheated steam. Lagging for boiler and superheated steam pipes, high-pressure turbines, &c., should not char, perish, or disintegrate at 1000 deg. Fah. For other purposes it should withstand 650 deg. Fah. The moisture content is specified.

Magnesia for sectional lagging is liable to rejection if it contains less than 88 per cent. of hydrated carbonate of magnesia, or if any other ingredient than asbestos fibre and magnesia be found in it. The weight of the finished lagging is of great importance, and the necessity for provision of a light, highly insulative material is obvious in view of the very large amount of lagging in a warship's machinery.

Rubber.—Goodrich "Cutless" rubber-lined bearings have been fitted in motor boats in the stern tubes and A brackets. No appreciable wear on either the shafts or bearing has been observed so far. Arrangements have been made to fit a rubber bush in the A bracket of a larger vessel for trial.

Many materials about which experience has been gained have not been mentioned, and those that have been referred to have had to be very briefly treated on account of the limited space available.

L.N.E.R.—Locomotive Coaling Plant in Scotland.

The old laborious and slow method of coaling locomotives is being rapidly replaced in all important depôts and yards by special equipment, of which we gave several examples in our issue of March 16th, 1928. The general design is similar in all cases, but details and elaboration vary. In all there is a raised hopper capable of holding a large quantity of coal. From openings at the bottom of this hopper the coal is allowed to fall by gravity into the tender. It is in the method of filling the hopper and discharging it and in the nature of the control and measuring apparatus that a certain amount of diversity occurs.

The most recent of these plants is one just completed at Kipps engine sheds—between Glasgow and Edinburgh—by Henry Lees and Co., Ltd., of Glasgow, to the requirements of Mr. H. N. Gresley. It is illustrated on page 434. The structure itself is made of ferro-concrete. The hopper is divided into two sections, one of which can contain 75 tons of the best grade and the other 125 tons of a second grade coal. It is filled from wagons which, as may be seen in our illustrations, are tipped sideways. The tipler is of the counterbalanced type and is capable of lifting wagons of 8 to 20 tons capacity over a receiving hopper 6ft. 6in. above rail level. Two independent chain feeders, each driven by a 2 H.P. motor, deliver the coal into one or the other of two 1-ton skips, which run on guideways and deliver the coal into the storage hopper through a chute. The skip motor can be operated independently of the feed motors, but during normal working the two are electrically interlocked and operate automatically. A flap in the chute deflects the coal into whichever of the two compartments of the storage hopper it is desired to fill. With the exception of this flap all the mechanism is operated electrically. As soon as a push-button switch is pressed to the "on" position, the skip which happens to be down is filled by the chain feeder until a weightometer actuated by the tension in the skip rope stops the supply, and starts the hoisting motor. The other skip descends and receives a load in the same way, the action going on automatically until there is not sufficient coal to operate the weightometer. It takes about 3 hours to deliver 200 tons.

The delivery of the coal to the tender is, also, controlled electrically. Each of the two compartments of the storage hopper delivers coal to an endless steel-belt conveyor, driven by a 4 H.P. motor, which carries it forward at a fixed speed and depth on to a two-way flap from which it falls on to the tender. The two-way flap diverts the flow of coal up or down line and facilitates the coaling of tank engines. When in a horizontal position, it prevents any chance of coal falling on to passing engines. Each of these conveyors is geared to an electrically operated recorder, or Cubi-Meter, which shows visibly the amount of coal delivered to the tender and at the same time makes an autographic record.

To coal, one of the enginemen steps on to a platform and selects from a rack a key bearing the number of his engine. He inserts the key in the recorder and in so doing registers the number. He then gives it a half-turn. That action starts the motors and coal, at the rate of 1½ tons per minute, is delivered to the tender. The action is stopped instantly by pressing a button, and at that moment the weight taken is recorded on a tape opposite the engine number. Thus a complete and automatic record of all the coal taken by engines is secured.

A zinc refinery is to be put up on Ile Perrot, Ontario, by Ventures, Ltd.

The Scope for Engineering Industries in Iceland.

In the course of a lecture, "On Visiting Iceland and Other Places," which was delivered by Mr. W. M. Hurrell before the Junior Institution of Engineers on Friday, April 4th, the following information on the progress of and scope for engineering industries in Iceland was given.

The construction of wooden houses in Reykjavik, the capital, is now forbidden by law. Hence there are many fine examples of reinforced concrete work. All the cement and steel work is imported, and the aggregate, obtained locally, is a sort of mill grit obtained from the mountains which are almost entirely volcanic. Except for a few birch trees, the island grows no timber.

The demand for electric current is very great, and has now considerably outstripped the capacity of the power station which is situated about 6 miles from the capital. The motive power is water and the maximum capacity of the station is 1500 kW alternating at 6600 volts, 50 periods. The current is conveyed by aerial cables to Reykjavik, and there transformed to 250 volts for lighting and other domestic purposes. The water power is derived from adjacent streams, which have been dammed, and it has only been in very exceptional weather that a temporary shut down has been experienced on account of ice. Tenders have just been invited for the construction of a new station at Sog, near Thingvellir, to be equipped with two water turbo-alternators of a capacity of 4500 kVA. The Lake of Thingvellir will supply the water power.

The smallest villages in Iceland have electric light, and in that matter as well as that of telephones, the country is comparatively well ahead of Great Britain. The available water energy of the country is estimated at 4 million H.P. A new broadcasting station is being erected, but many of the wealthier people have wireless sets which pick up European stations.

There are three small engineering works in Reykjavik, one of which can make iron castings up to about 1 ton in weight, and has a slip for ship repair work. Riveting work is carried out skilfuly, and considerable use is made of electric and oxy-acetylene welding. The use of internal combustion engines is increasing and there are several small refrigerating plants about the country.

The numerous hot water springs are utilised for the heating of buildings, and just outside Reykjavik is a public laundry, the water for which comes out of the ground at 98 deg. Cent. At Akurlyri is a sanatorium, the last word in modernity in such institutions, which is heated entirely from a hot spring, and an adjacent farmhouse, including the cow-houses, is also heated by the same means.

The country being very mountainous and sparsely inhabited there were until recently practically no roads, but the Government is now pursuing an active policy in that direction. At the end of last century there was hardly a wheeled vehicle in the country, goods being carried by pony caravans. A road 250 miles long has now been made between the capital and Akureyi, the most important town in the north, and for the first time in history a wheeled vehicle—a motor car—made the journey last year in 21 hours, which time will undoubtedly be reduced this summer. The road is impassable in winter. An air service was organised between these places last year, and the Government has now purchased two seaplanes for mails, &c., the passage from the north taking 2½ hours.

The growth in the number of motor vehicles is remarkable. The pony caravans are being displaced by motor lorries, and last year 1100 cars, mostly of American make, were imported. The total in the country must be well over 1700.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Clearing Up.

INDUSTRIALISTS in the Midlands and Staffordshire have this week spent much time in digesting the Budget and clearing up at the works in readiness for the Easter vacation. Now that the horizon is cleared, so far as the Government's interference with industry is concerned, it only remains for the Easter holidays to be completed and the plant again to be got into motion before some accession of business can be confidently expected. Business which has been for some time in suspense should then be released and tentative schemes should almost immediately take shape, infusing a limited new impulse to trade in general. Generally speaking, manufacturers, engineers, and producers of iron and steel began their holiday in a much lighter frame of mind, and for the most part they seemed optimistic as to the future. Last week's quarterly meeting, as anticipated, provided no great volume of business, and passed leaving little or no change in the general trade position. Demand in all departments was small, and though a fair number of orders was put through, they did not in the aggregate call for a tonnage which could be said to prove satisfactory to producers. The engineering trades in this area are a little more buoyant, but mechanical engineers report that while they are steadily employed they cannot see far ahead. Rolling stock makers continue to receive useful orders, structural engineers are only moderately active, but electrical engineers remain in a good position. Small tools for the engineering industry have been quiet, and there is no visible improvement in the heavy edge tool trade. There is ample room for improvement all round, and hopes are expressed that the near future will witness some real enlivenment of conditions in the principal manufacturing trades in this district.

Midland Manufacturers Distressed.

Manufacturers in this area who are affected by the Safeguarding of Industries Act say that the Chancellor has put "another nail in their coffin." They have in some cases a respite in that the duties are not to be abolished forthwith, but are to be permitted to run their normal course, but the knowledge that they are not to be renewed makes cheerless fare. Foreign competition in some of the industries at present safeguarded is even now very severe, and Staffordshire and Worcestershire makers of enamelled hollow-ware say there is nothing to prevent that industry from sinking to the low level it reached before it received protection from foreign competitors. The artificial silk industry in Coventry and Wolverhampton is also likely to suffer considerably, and the discharge of a large number of hands in that industry in the near future is almost certain. Many Midland and Staffordshire trades will be seriously affected by the non-renewal of these duties, and the manufacturers concerned take a gloomy view of the outlook.

Automobile Engineers Relieved.

It was with relief that Midland manufacturers learned on Monday that the McKenna Duties are to be retained. The retention of this measure is of vital importance to this district, and manufacturers of motor vehicles have been saved from what would undoubtedly have been a great adverse "blow" at a time when more than any other they are in need of a favourable wind. Business has been retarded for some months by the knowledge that these duties might be withdrawn, and it is sincerely hoped now that the future is clear, business will no longer be held in check. Programmes of industrial expansion have been spoken of in the past if the industry concerned continued to be Government-assisted, and iron and steel masters and engineers here are looking for these schemes to be put into hand. Midland industrialists are more than relieved; they have taken on an optimistic mood, and there is every likelihood of a bigger "hum" in the workshops after the Easter holidays than has been heard since the year opened.

Coventry Engineering

There is a noticeable improvement in the position of the Coventry automobile engineering industry on that existing a fortnight ago. Some hundreds of hands have been re-absorbed by the industry, and there is now a great deal of activity at the principal works. The flow of orders, especially for light cars, is said to have accelerated considerably, and the announcement by the Chancellor of the Exchequer that the McKenna Duties are to be retained has greatly cheered manufacturers. They regard the duties as vital to the interests of the industry. It has been pointed out for some time now that upon the quantity produced depends the price, and that any reduction in the number of cars produced and sold brought about by a cessation of the McKenna Duties, would have increased production costs and decreased the sale ability, both at home and overseas. Manufacturers will now be able to go right ahead with schemes for increasing production which have been held up pending the Government's decision as to these duties. Other of Coventry's engineering industries are moderately employed, but next week employees will spend a portion of the week holiday-making.

Ironworkers' Wages.

The bi-monthly ascertainment of selling prices for the determination of ironworkers' wages under the sliding scale scheme of the Midland Iron and Steel Wages Board shows that as a result of best bar iron making a considerable contribution to the increased turnover in January and February, an advance of 2½ per cent. in wages is made possible. Ironworkers in the Midlands will during April and May receive payment on the basis of 32½ per cent. above the 13s. 6d. rate for puddling.

Pig Iron.

In the pig iron industry, where in the Midlands there are now seventy-one furnaces in blast, a number of small purchases of foundry iron added to the contracts on smelters' books are keeping the furnaces employed. Owing to the general abstention of buyers, some stocking of material has become necessary at most of the furnaces. The Association prices are rigidly adhered to, and furnacemen do not hold out any prospect of price concessions. They maintain that their selling rates compare favourably with those of Cleveland, despite the recent reduction of the latter by 5s. per ton. Consumers say they are determined not to buy more iron than is absolutely necessary for immediate needs until prices are lowered. It is expected that the Central Pig Iron Producers' Association will review selling rates at its meeting at the end of this month, and consumers are hoping some concession will be made. They consider that the time has now come when furnacemen can afford to pass on to them some of the benefits accruing from cheaper furnace coke. Derbyshire smelters say that £3 18s. 6d. is a very reasonable figure for No. 3 foundry iron, considering their past losses. Northamptonshire foundry costs £3 15s. delivered Black Country stations. Forge iron is 4s. per ton less in each instance.

Steel.

The demand for steel continues on a hand-to-mouth basis, and the consequent frequent roll-changing results in increased production costs and lower profits. The Steel Association maintains its prices for heavy steel, and points out to users who ask for better terms that, notwithstanding the writing down of capital, representative coal, iron and steel concerns, in which nearly 32 millions are invested, earned last year only £411,000. Steelmasters are pressing engineers for specifications which do not come up to anticipations. They meet with little success, however, constructional engineers not being sufficiently well placed to give out any heavy tonnages of building steel. The small new orders which come to hand are very welcome, but they are quite insufficient to balance the amount of work going out. In the semi-finished branch of the industry, native makers continue to vie with the foreigner for the available business. Bars and billets are in no better request, and native and foreign suppliers alike complain of the poorness of demand. Continental producers adhere to their fixed prices in an endeavour to steady the market. In Birmingham this week 2in. billets were quoted delivered £5 12s. and 2½in. 1s. less. Sheet bars were named £5 13s. English billets are priced at £6 2s. 6d. Staffordshire re-rollers ask £8 for small bars as a minimum.

Staffordshire Bar Iron.

The marked bar department is the only branch of the Staffordshire finished iron trade which shows any vitality. In it a fairly good inquiry prevails, and makers have no difficulty in getting the full figure of £12 10s. per ton for their output. They complain, however, that the profit margin is very small, and that pig iron is dearer than it should be. They lose no opportunity of letting smelters know their views on this subject, and they hope that before long some concession will be forthcoming. Makers of Crown bars and nut and bolt and fencing qualities are still in a most unenviable position. Few orders come their way these days, and selling prices are in a more or less liquid state. In the latter department foreign competition is as severe as ever. Belgian No. 3 bars, used by Black Country makers of nuts and bolts, are among the few uncontrolled foreign materials. Merchants in Birmingham this week offered supplies at £5 2s. 6d. f.o.b. Antwerp, the equivalent of £6 5s. delivered here. There is little business about, however. Wrought iron tube strip keeps up well, demand being fair and values firm at £11 2s. 6d. per ton.

Galvanised Sheets.

The galvanised sheet trade has made no real recovery, the increase in business a few weeks ago as a result of the fixing of basis selling prices not having been maintained. Export demand has relapsed into its former dulness, while demand from users at home is small and irregular. The position has been further prejudiced by the increased difficulty of trading with Australia. Some orders are reported to have been countermanded, and there seems little prospect of the same amount of business being done in the future with this market as has been the case in the past. Galvanised sheets of 24 gauge continue to be quoted £11 17s. 6d. f.o.b. There is slightly more movement in black sheets, but trade remains below normal for the time of the year. Very little is being done in this district with tin-plates. Values, however, are maintained.

Furnace Coke.

Smelters in the Midlands are now able to obtain ample supplies of blast-furnace coke at comparatively reasonable prices. Coke, indeed, is cheaper now than it has been for a long time, to-day's price being 3s. 6d. to 4s. per ton lower than that which ruled at the beginning of the year. As furnacemen's contracts run out and are renewed, the advantage will be felt, and it is just possible that smelters will then be content to pass on some of the benefit to users of pig iron. Just now many furnacemen are paying January prices, contracts having been made then for at least three months, but many of them are now on the point of expiry.

Scrap.

The steel scrap position continues very difficult, owing to the slowing down of consumption at the steel works in this district and South Wales. Scrap which was being eagerly sought twelve months ago is now almost unsaleable. Consumers to-day hesitate to pay £3 2s. 6d. per ton for heavy steel scrap, whereas a year ago they readily paid £3 12s. 6d. During past weeks there has been a marked decline in the amount of scrap transferred from the Midlands to South Wales, and there are no signs at date of any improvement in the immediate future, works being reported as well stocked.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery Exports Decline.

ANOTHER unsatisfactory month for textile machinery exports is disclosed by the trade returns for March, the total being only £775,800, compared with £843,000 and £1,080,400 in the corresponding period of 1929 and 1928 respectively. Last month's figure included 6071 tons of spinning and twisting machinery, valued at £590,500, and 1386 tons of weaving machinery, valued at £129,000. Bigger shipments to five overseas markets were not sufficient to counterbalance the declines in the remainder. British India continues to head the list of buyers, shipments thence reaching a total value of £254,000; France comes second with £72,200, followed by China with £65,400; Japan, £45,200; Russia, £40,200; the United States, £32,000; South America, £28,000; the Netherlands, £26,800; Germany, £26,400, and Australia, £21,300; exports to "other European countries" amounting in the aggregate to £135,100. The extent of the decline over the first quarter of the present year is most pronounced, the value being only £2,539,000, against £2,849,000 last year and £3,055,000 in the first three months of 1928.

Short Time in the Locomotive Shops.

Starting at the end of next week short-time working is to be resumed at the Horwich, Crewe and Derby locomotive works of the London, Midland and Scottish Railway Company, a five-day instead of the five-and-a-half-day week then coming into operation. It is announced that about 3000 men will be affected at the Horwich works, 7000 at Crewe and 4000 at Derby, and the expectation is that the five-day week will continue throughout the summer.

New Bridge for Old.

The replacement of a much smaller structure by a new steel bridge of about 500 tons in weight, carrying the Cheshire Lines Railway over Walton Hall-avenue, Liverpool, was successfully completed on Sunday, railway traffic being suspended from 10 p.m. on Saturday until Sunday evening. The new bridge is 148½ft. long, 31½ft. wide and 23½ft. deep, and was built and assembled for testing at Warrington.

Personal.

Mr. J. A. Sumner, assistant engineer to the Mid-Cheshire Electricity Supply Company, has been appointed distribution engineer on the staff of the chief engineer and manager to the West Midlands Joint Electricity Authority, of which the area of supply in Shropshire and Staffordshire extends over about 1600 square miles.

Non-ferrous Metals.

Conditions in the non-ferrous metals market during the past week have been very irregular, for whilst spelter has relapsed after its slight gain of the previous week and copper has experienced a further fall, both tin and lead have registered some recovery. Notwithstanding the continued increase in warehouse stocks of tin in this country, prices in that section have shown renewed strength and although the peak of the week has not been maintained, the gain on balance is in the neighbourhood of £2 a ton. Rather more buying interest in the metal has been in evidence. The copper market is still suffering from the lack of confidence among consumers, for the demand both for standard and refined descriptions is very restricted. The former is cheaper at the moment of writing by from £1 to £2 a ton; according to position, whilst a further decline in electrolytic metal has to be recorded. In the case of lead, the demand has been of moderate extent and the market has been a shade stronger, values being higher by about 5s. a ton, which represents a recovery of about half of the loss sustained in the previous week. The slight improvement in spelter, referred to a week ago, has not been sustained, and quiet trading has been accompanied by a certain amount of weakness.

Iron and Steel.

There is still little sign of the much-needed spurt in the iron and steel trades. The call for foundry iron continues very slow, owing in a large measure, of course, to price uncertainty, though unsatisfactory conditions at the consuming end of the trade are exercising their effect. Buying of pig iron this week has almost entirely been a matter of small lots for prompt delivery, and until prospects as to prices are made a little less obscure by Midland producers at their meeting next week there is no likelihood of even a slight improvement. Staffordshire and Derbyshire No. 3 iron are quoted for delivery equal to Manchester at 77s. per ton, with North-East Coast brands at about 80s., Scotch at 95s., and hematite at 92s. There have been reports during the past few days of rather more inquiry circulating among constructional engineers in the district, and there is a possibility in this of better conditions ultimately at the steel end, although in the meantime the business moving remains very small. Bars and plates generally, except the locomotive varieties, which are in fair request, are attracting small attention. Neither in the market for home-produced materials nor in continental finished and semi-finished steel has there been much further quotable change in the price situation. In respect of the latter, the demand for imported goods is largely a matter of transactions in second-hand parcels.

BARROW-IN-FURNESS.

Hematite.

The market is inclined to be thin, although makers are not actually short of orders, their contracts carrying them to the end of May. There are certain stocks held at some works, but they have not assumed serious proportions as yet. There is news of the putting

out of a furnace at Millom, which, when it first obtained currency, caused a shaking of heads; but the company has cleared the air by stating that another furnace, which has recently been completely overhauled, will commence producing almost immediately. The fact that the steel departments at Barrow and Workington are kept going, accounts for the clearance of considerable iron at the respective works and keeps stocks down and production up. Under present conditions the restarting of the Carnforth and Askam works seem very remote. At present, buyers are anxious for a reduction in price, which producers are unable to agree to owing to heavy fuel costs. The local demand for ore is about the same, but outside business in native ore is not so bright as it was. The steel market is only moderate and orders are difficult to secure and prices are very keen. It is said that the smaller orders pay best as the large ones are cut very fine.

Shipbuilding.

Shortly Vickers-Armstrongs are going to create a record. It is their intention at an early date to launch three submarines of the latest type for the British Admiralty, all on the same day. Some time ago two were launched on the same day, now the Barrow firm goes one better. The torpedo destroyer "Arrow," built at Barrow for the British Admiralty, has been completed. She has finished her trials and left Barrow this week for Chatham. She has 34,000 shaft horse-power.

SHEFFIELD.

(From our own Correspondent.)

Open-hearth Production Reduced.

In view of the coming Easter stoppage, there has been a further shrinkage of business in the steel trades. There is a continued absence of bulk purchasing, most of the quantities ordered ever since the beginning of the year having been of a hand-to-mouth character, and now many firms are curtailing or suspending deliveries of materials for the time being. The output of open-hearth steel, which had been maintained hitherto in spite of disposal difficulties, has now been reduced at one or two plants, and, unless there is an improvement in the demand after the holiday, it may be necessary to damp down several more furnaces. There is depression in the scrap market. Forward buying of this material has been on a low scale throughout this year, and with the fall in consumption prices have dropped to an abnormally low level. The finished branches, so far as ordinary lines are concerned, are not at all well placed and are particularly short of foreign orders; but the special lines maintain a considerable amount of activity.

The Lighter Trades.

Some branches of the tool trade are fairly well off for work, but this remark does not apply to files and saws, both of which departments are short of orders. The cutlery and plate trades show a considerable falling off in output as compared with the corresponding period of last year. While some firms have valuable work on hand in the execution of contracts for the equipment of steamships and hotels, business done through ordinary shopkeeping channels is disappointing. The export side is dull. The safety razor blade branch, although not as well occupied as it has been accustomed to for the past two or three years, is still turning out very large quantities of goods, which are in growing reputation in all parts of the world. James Neill and Co., a well-known firm of steel manufacturers who added razor blades to their products a few years ago, are competing successfully for trade in many markets which have formerly been strongholds of American products. During one recent period of sixteen days, they received orders from no less than fourteen different countries—Australia, South Africa, India, Belgium, Germany, Austria, Norway, Greece, Poland, Colombia, Peru, Brazil, Manchuria and Korea.

A Safeguarding Plea.

I write before the introduction of the Budget and am therefore unaware of the Chancellor's intentions with regard to safeguarding and other similar duties. But, whatever the Labour Government may think, it is clear that the trades to which these duties have been applied have benefited by them, and are in favour of their continuance. Many of those engaged in the manufacture of motor car supplies have several times supported the retention of the McKenna Duties. A concrete example of this feeling was brought before the House of Commons last week, when one of the local Members presented a petition asking for a continuance of the Safeguarding Duty on imported cutlery—which expires on December 21st next—for a further five years. The petition was signed by 6000 employers, working cutlers, grinders, &c., engaged in the industry, including the Master Cutler, the President of the Sheffield Cutlery Manufacturers' Association and the secretary of the Sheffield United Cutlery Council, representing all the trade unions in the industry. It set forth that the continuance of the duty "is of the utmost importance to the industry, inasmuch as the existing duty has greatly benefited the trade and is regarded as vital to its welfare, that it has encouraged a new branch of the cutlery trade, namely, the manufacture of safety razor blades, that it has relieved unemployment and that if the duty is removed the trade and industry is certain to suffer very grievously." [Since our correspondent wrote the Chancellor has announced that the Safeguarding Duty on cutlery will be allowed to expire on December 21st this year.]

A Firm's Acquisition.

The well-known firm of Edgar Allen and Co., Ltd., Imperial Steel Works, Tinsley, Sheffield, has acquired from Ord and Maddison, Ltd., of Victoria Works, Darlington, that portion of their business relating to rotary screens, rolls, stone breakers and tar macadam mixers. In future, Messrs. Allen will undertake the manufacture and sale of these machines and the various fittings in connection with them. They already possess their own standard designs of screening and crushing machinery, but by acquiring the Darlington business they will be able to offer a larger range of machines.

Buenos Aires Exhibition.

Sheffield manufacturers interested in the South American trade are to meet at the local offices of the Federation of British Industries on Monday, April 28th, to discuss a proposal for a composite exhibit of Sheffield goods at the British Empire Trade Exhibition which is to be held at Buenos Aires from February to April next year. By this plan, representation can be obtained at the Exhibition by firms to whom the expense of an individual stand would be prohibitive. Arrangements have already been made by the F.B.I. for a composite stand for its members, but it is thought that Sheffield would appreciate a separate display of its products in a suitable pavilion. The Sheffield Chamber of Commerce is co-operating with the F.B.I. in the matter, and it is hoped that a sufficient number of firms will respond, so that the scheme can be proceeded with.

Directors Resign.

Something like a sensation has been caused in steel-making circles by the resignation of three directors of one of the best-known firms. The firm is that of William Cooke and Co., Ltd., and the resignations are those of Mr. H. C. Else, chairman and managing director, and his two sons, Messrs. S. C. Else and L. H. Else. The secretary sent out a circular to the shareholders last week-end announcing these resignations, and adding that the directors—the board now consisting of Messrs. D. Lewis, J. Watson Smeeth and J. W. Stevenson—"are fully alive to the need for minimising any dislocation of the company's business, and arrangements are being made to that end." Mr. H. C. Else has been with Messrs. Cooke for something like forty years, and has been chairman and managing director for a long time.

Railway Material.

The heavy steel trade of Sheffield is badly hit by the shortage of orders for railway material, especially rolling stock. The increasing tendency of the railway companies to manufacture for themselves is naturally not welcomed by the Sheffield firms, which have on several occasions put forward arguments to show the companies that it is to their interest to support private firms. Nor is Sheffield alone in its attitude, for it has the support of Leeds. It is not, however, able to bring the Association of British Chambers of Commerce round to its way of thinking. Last year, the Sheffield Chamber asked the Association to adopt a resolution urging railway companies to curtail their manufacturing activities, but was defeated. Last week Leeds introduced a similar motion, which was seconded by Sheffield. The representative of the Leeds Chamber said that railway grouping had been disastrous to some of the private manufacturers, and this effect had been accentuated by the entry of two armament firms into the industry since the war. Through rationalisation schemes and loss of orders, five previously prosperous firms making railway material in the district had ceased to exist during the last few years. The Sheffield speaker maintained that to-day the manufacturer could give the railways all they wanted, and that the railways could find enough work for their shops by concentrating on the repair of locomotives and wagons. The resolution was, however, again defeated. One of the speakers in opposition was Mr. Nesbitt Wood, of Derby, who described it as "futile and inconsistent." He said it was futile because the Association had no power to dictate to the railway companies, and it was inconsistent because no manufacturer among them would agree to be dictated to as to what he should make and what he should put out.

New Showrooms.

This week Joseph Rodgers and Sons, Ltd., opened at their Sheffield works new showrooms, one of which in particular—the commercial showroom—is worthy of notice because it is more elaborate than anything of its sort, probably, in any part of the world. It has been designed not merely to display articles behind glass cases, but to have available for the immediate inspection of buyers complete ranges of all the firm's lines. The groups are so arranged that the buyer may see at a glance everything in the cutlery line which is required in any particular market of the world. Thus, not only can he inspect those which are specially required in his own market, but he can see if there are specialities in other markets which would be suitable for his own. As a rule, when one goes to Sheffield or elsewhere, one is shown into an office or warehouse and goods to be inspected have to be brought in, laboriously unwrapped and wrapped up again, while many of the things that might interest the buyer are never seen by him.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Shipbuilding Industry.

Although there is considerably more merchant tonnage being built at North-East Coast yards than was the case a year ago, there is at the same time the depressing spectacle of berths being occupied in the Tyne, Wear, and Tees by idle vessels of many sizes, from the coaster to the big general cargo boat. Much of the work in hand is oil tank tonnage for Norwegian and other foreign owners, and no fresh orders are being placed for ordinary tramp steamers. Some shipbuilding firms will be busy all this year, but there are others which are nearing the end of current contracts. Shipowners are having an extraordinarily bad time. Most of the Northern firms have boats laid up. In one instance, a company has eight ships out of service. The steel screw steamer "Port Alfred," launched from the Tees shipyard of Smith's Dock Company, Ltd., and built to the order of Canadian owners, is of somewhat unusual design. It is about 345ft. long, and has exceptionally large hatchways, which are fitted with steel covers. The vessel is arranged for carrying timber and other bulk cargoes. The masts are about 120ft. in height, with twelve large steel derricks operated by specially designed winches. She has a cruiser stern and a round stem. The machinery is also to be constructed at the firm's Tees engineering establishment.

Cleveland Iron Trade.

While the hopeful tone has not left the market, indication of early return of normal activity is not at all bright. The demand for Cleveland iron falls far short of expectation, after the recent cut in prices. The bulk of the make still goes to producers' own consuming departments, but ironmasters report fairly substantial sales to local and other home users. Second hands have effected a few more sales with overseas firms, and are not without hope of further improvement in export business. Quotations are steady and firm, No. 1 Cleveland foundry iron being 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; and No. 4 forge, 66s.

Hematite Pig Iron.

Conditions in the East Coast hematite pig iron trade are going from bad to worse, and signs of early check of the increasingly unfavourable statistical situation are absent. Producers are hampered by heavy stocks, and values are still falling. Makers are prepared to book orders at several shillings per ton below cost, and merchants, in their anxiety to lighten their considerable holdings, offer iron at below figures named by producers. Business is almost confined to small sales for home purposes, export trade being still held up by the comparatively cheap rates at which continental hematite is obtainable. Quotations are difficult to fix definitely as prices accepted vary a good deal; but there are sellers on the basis of ordinary qualities at 75s. No. 1 quality is at a premium of 6d. per ton.

Ironmaking Materials.

Foreign ore merchants fail to find consumers prepared to enter into negotiations for new purchases, and quotations are nominal, but imports are heavy. Best Rubio is put at 21s. c.i.f. Tees. Blast-furnace coke is plentiful, but buyers are backward in anticipation of lower prices ruling in the near future. Sellers ask round about 19s. for good average qualities delivered at North-East Coast works.

Manufactured Iron and Steel.

Keener competition is now being experienced in the manufactured iron and steel trade, especially for semi-manufactured materials, but buying in this district is not on a large scale. Shipbuilding and other constructional steel is in fair demand, but orders would be welcomed in other sections of the industry to ensure the present level of production. Prices are firmly maintained.

The Coal Trade.

Conditions in every section of the Northern coal trade remain unsatisfactory, owing to a continued lack of new business. Merchants sound all continental centres freely, but find that stocks of all grades of coal are heavy, and that the consumptive demand is much below average seasons. There is consequently little chance of any appreciation setting in for a few weeks. Lost days have been rather frequent at some of the collieries, but there is likely to be a steadying influence by reason of the Easter holidays, which will be longer than usual at the pits, extending in most instances from Thursday to Tuesday, on account of the poor demand. In Northumberland steams, the minimum prices are nominal as contractors have so much to sell at the best prices they can get, and these are about 9d. per ton below the colliery quotations. Best qualities are about 13s. 9d. to 14s., with seconds at 13s. to 13s. 3d. The market for steam smalls is quietly steady, and values remain undisturbed at 10s. 6d. to 11s. for best qualities. The general position is unchanged for all Durham qualities, and there are ample stocks available of any description. Accordingly, values are difficult to maintain, even at the recent low level. There is slight pressure for best bunkers over the holiday period, but only strong enough to steady prices, which are quoted unchanged at 15s. to 15s. 6d., while secondary classes are weak at 13s. 6d. to 13s. 9d. Gas coals are moving off slowly at 16s. 3d. to 16s. 6d., and special Durham qualities at 16s. 9d. Secondary gas and all qualities of coking unscreened are readily obtainable at from 13s. 6d. to 13s. 9d. Prospects for the early May trade are not encouraging, hence sellers offer at the above values for any date of May shipment. Gas coke stocks are very small, and, with a good general inquiry, merchants quote firmly at 21s. 6d. to 22s. for any parcels available. Foundry coke demand remains idle, and with the abundance of stocks available, prices are quoted unchanged at 18s. for good makes, and 26s. to 30s. for beehive or other special grade foundry.

Cleveland Miners' Wages.

The Cleveland ironstone mineowners' and miners' representatives met on Monday, when the question of the wages to be paid during the next three months was under consideration. An agreement was reached under which the wages of the men will be increased from April 28th by 1 per cent., with certain reservations.

SCOTLAND.

(From our own Correspondent.)

Steel.

Conditions in the Scottish steel trade are unsatisfactory. For some considerable time now only a fair proportion of the plants have been operating, and the quantity of new business being booked at present hardly

justifies a maintenance of the present rate of output. As a matter of fact, some firms have already reduced the amount of plant in operation. It seems apparent that the main reason for the existing state of affairs is the quietness in the shipbuilding industry. The output from Clyde yards has been moderate, but at the large yards most of the berths are unoccupied, and there is little prospect that the advent of new business will exceed or equal the rate of output for some time to come. Consequently, the demand for steel for shipbuilding purposes is likely to suffer a further shrinkage. Steel sheets are rather irregular, the light gauges being fairly active, but the heavy varieties are unsatisfactory. Galvanised descriptions have only a moderate turnover.

Tubes.

The present position in the tube industry strikes another unsatisfactory note. During the greater part of last year this industry constituted a bright spot, but since the beginning of 1930 conditions have almost completely changed. The general demand is now far below normal, and, indeed, business is so quiet that two establishments have closed down meantime, and in others the butt welding department has been put out of operation. Under the cartel arrangements, tube makers are receiving their share of orders, but there have been developments, particularly affecting British makers, not the least of them being the loss of Australian business by reason of fiscal changes and the financial difficulties in the Commonwealth.

Iron.

In the bar iron and steel re-rolling departments the tale of depression is carried on. Demands are comparatively few, and employment is intermittent. Bar iron prices are unchanged, and re-rolled steel is quoted £7 12s. 6d. per ton, home or export.

Pig Iron.

Business in pig iron is quiet, though fairly regular. Pig iron from India is coming here freely and continental basic material is still on offer in this district, but local makers are maintaining their prices by agreement. On the other hand, it is reported that British as well as American pig iron is finding its way into continental districts.

Scrap.

The demand for scrap is comparatively quiet at present, and prices are fairly easy at 65s. heavy steel, 62s. 6d. heavy basic, and 69s. 3d. per ton for cast iron machinery scrap.

Coal.

There is no improvement in the coal market. Export coal has a poor demand, and in those districts chiefly interested, a considerable amount of idle time is recorded. Consumers abroad are evidently well bought up, and some are, in fact, endeavouring to prolong deliveries and others suggest a total relief from contracts. Under the circumstances the collieries have great difficulty in getting shippers to take up fuel arranged for some time ago. Forward business is practically impossible. Exporters receive inquiries, but are wholly unable to quote acceptable terms. Prices on the whole show little change, but the tendency is still downwards.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THERE is no pre-holiday rush for steam coals, such as was experienced in better times years ago. On the contrary, the position of numerous collieries during the early part of this week was the reverse of satisfactory, as a number of them were at a standstill, including several producing the very best grade of Admiralty coals. At the end of last week, there were as many as thirty-two idle tipping appliances at the various docks, and yet the returns of the Great Western Railway Company showed that shipments were just over 601,000 tons, which was an improvement upon the preceding week of 67,000 tons. This quantity comes as a considerable surprise, particularly as throughout the whole of last week the number of tipping appliances that were idle varied from about twenty to thirty daily. It shows for one thing that the docks being free from congestion and with coals plentiful, good loading work must have been done. The result is all the more remarkable as it is in such direct contrast with the state of business on the market. It points to the fact that the big combines must have considerable commitments of which little or nothing is heard on the market, and also that tonnage must be held by them on voyages or be chartered quietly without knowledge of it coming to the market generally. Yet despite this, coals of almost every description are in excess of requirements for prompt shipment, and in only a very few cases, such as collieries producing coals which are being shipped for account of the Italian States Railways, is work at the pits at all regular. Arrivals of steamers over the week-end were by no means unusually heavy, as on Monday the position at the docks was that twenty-six tipping appliances were idle, and there were only four steamers waiting to load at Newport. New inquiries for steam coals continue to be meagre in the extreme. The only one of note is from the Norte Railways of Spain for 15,000 tons to be delivered in four cargoes at Tarragona and Valencia. Two cargoes are to be shipped at the end of this month or the early part of next, and the second two cargoes at the end of May or early June. As a rule, there is very keen competition for this business, notwithstanding the onerous conditions of the contract.

Coalfield and Docks Holidays.

Quite a number of collieries work in this district on Good Friday, and the official holidays in the coalfield will be Monday and Tuesday next. So far as the docks are concerned, the coal trimmers arranged to work two short shifts on Thursday, there being no work on Good Friday, while work will also be suspended on Monday and Tuesday of next week. Full work will be resumed on the Wednesday. The Cardiff and Bristol Channel Pitwood Importers' Association decided that the pitwood workers' holidays should be Good Friday, Easter Monday, and Tuesday.

Tin-plate Industry.

Negotiations were conducted at the end of last week between representatives of the Welsh tin-plate trade and the Transport and General Workers' Union respecting the rate of pay and the manning of the new magnetic feed pots which have recently been introduced at the Burry Tin-plate Works, Llanelly. These feed pots have a greater output and need fewer men to operate than those of the old system, and the probability is that in the course of time they will be installed at other tin-plate works in this district. Experimental rates and conditions have been in force as the result of arbitration, but the purpose of the conference on Friday last was to reach a permanent arrangement. The representatives of the men naturally expressed apprehension regarding the possible displacement of labour which the more extensive use of these feed pots would have, and they did not agree to the suggested rates of pay or to the number of men required to work a pot. In the end, it was decided to refer the whole subject to a sub-committee for the purpose of examining the matter from all points of view. The thirty-first annual trade conference of the tin-plate section of the men's union was also held at Swansea last Saturday, when the Chairman referred to the question of the effect of the introduction of new inventions upon labour, and said, regarding the new magnetic feed pots, that if the offer from the employers' side were accepted as a solution, 75 per cent. of the men in the tinning department would be deprived of a livelihood. In the course of the conference proceedings, a resolution was passed calling upon the Government to introduce a Bill making provision for a general reduction of working hours of all industrial workers with a view to absorbing as many unemployed as possible. The men's representatives on the Tin-plate Joint Industrial Council were urged to continue their efforts for the provision of a superannuation scheme for tin-plate workers and the payment of wages for the annual August stop week. It was also declared that the employers should seriously consider reducing the burden on industry by employing a very much less supervisory and managerial staff.

Moving Mountain and Colliery Property.

During last week-end considerable damage was done to the property of the Powell Duffryn Steam Coal Company by a landslide at New Tredegar. Cefn Uchdin, the mountain towering over the New Tredegar Colliery, has been slipping into the valley since Friday last week. Thousands of tons of rock and earth have fallen upon the colliery buildings. On Friday men were paid off at the colliery office. During the week-end the office was demolished, and on Monday men were engaged in digging and searching for books and records. One of the two colliery shafts was unapproachable, as the moving earth had crushed the heavy steel girders like matchwood. The company has endeavoured to make the most of its opportunity during a cessation in the movement of the mountain to save the colliery power-house, one of the shafts and very valuable machinery. Fitters and welders have been working feverishly to remove plant and safeguarding the pipe line which carries compressed air to the Tynewydd Colliery and other Powell Duffryn pits further up the valley. A great length of the main road from New Tredegar to Abertysswg has been swept away by the movement of the mountain, and only a few concrete posts are to be seen sticking out of the *débris* some feet away from where the road formerly existed.

Current Business.

The tone of the steam coal market displays quietness all round. The demand is wholly insufficient to absorb outputs, and tonnage in dock is much below what is required. Apart from the paucity in the inquiry for prompt supplies of coal for various industrial purposes abroad, the demand for coals for bunkering of steamers is further reduced. Tonnage with an aggregate carrying capacity of round about 4,500,000 tons is now reported to be laid up. All qualities of coals are on the minimum. Coke has met with a fair inquiry, and patent fuel is steady. Pitwood has improved to 26s. 9d. to 27s., on account of the reduced quantities available for delivery this week.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

THE British National Committee of the Electrical Industry Committee of the British Engineering Standards Association is now actively engaged in preparing for British participation in the forthcoming important meetings of the International Electrotechnical Commission. The technical meetings will be held in Stockholm during the first week in July, after an opening meeting in Copenhagen. The closing Plenary Session, together with a meeting of Council, will take place in Oslo. There will be meetings of fifteen Advisory Committees dealing with the following subjects:—Nomenclature; Rating of Electrical Machinery; Symbols; Steam Turbines; Aluminium; Voltages, including Tests on High-voltage Insulators; Electric Traction Equipment; Insulating Oils; Overhead Lines; Radio Valves; Measuring Instruments; Rating of Rivers; Tests for Shellac; Rating of Oil Switches; Internal Combustion Engines.

A very influential delegation, consisting of representatives of Government Departments, the Institution of Electrical Engineers, the Institution of Civil Engineers, the Electricity Commissioners, the Central Electricity Board, and manufacturing, research and supply organisations interested in the work of international standardisation in the electrical field, will be present from Great Britain and delegates from the Dominions will also be present. The Scandinavian National Committee of the I.E.C. is making arrangements for the visiting delegates to see some up-to-date hydro-electric and other plant.

LAUNCHES AND TRIAL TRIPS.

DELFSHAVEN, steamship; built by Wm. Gray and Co., Ltd., to the order of N. V. Gebr. van Urden's Scheepvaarten Agentuur Maatschappij; dimensions, 434ft. 4in. by 54ft. 3in. by 29ft. 8½in. Engines, balanced quadruple inverted direct-acting surface condensing; constructed by the builders; trial trip, March 21st.

TABINTA, motor cargo ship; built by the Netherland Shipbuilding Company, to the order of N.V. Stoomvaart Maatschappij "Nederland"; dimensions, 465ft. by 62ft. by 36ft. 3in.; to carry 10,000 tons. Engines, 7000 B.H.P. Sulzer; launch, March 21st.

DJEBEL-AURES, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Compagnie de Navigation Mixte; dimensions, 336ft. by 44ft. 9in.; to carry 3500 tons. Engines, double-reduction geared Parsons turbines; trial trip, March 24th.

WELCOMBE, steamship; built by William Gray and Co., Ltd., to the order of Pyman Bros., Ltd.; dimensions, 434ft. 9in. by 55ft. by 28ft. Engines, balanced quadruple, inverted, direct-acting, surface condensing, reciprocating; constructed at the builders' Central Marine Engine Works; trial trip, March 26th.

MUSA, steamship; built by Workman Clark (1928), Ltd., to the order of Elders and Fyffes, Ltd. Engines, turbo-alternator; constructed by British Thomson-Houston Company, Ltd.; launch, March 29th.

DEEMORE, steam tug; built by Cammell Laird and Co., Ltd., to the order of Furness, Withy and Co.; dimensions, 100ft. by 24½ft. by 12½ft. Engines, triple-expansion surface condensing; launch, April 2nd.

MARGAM ABBEY, steamship; built by Wm. Gray and Co., Ltd., to the order of Frederick Jones and Co.; dimensions, 315ft. 8in. by 44ft. by 23ft. 2in. Engines, triple-expansion, 21½in., 36in., 60in. diameter by 39in. stroke, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 3rd.

PRINCE ROBERT, steamship; built by Cammell Laird and Co., Ltd., to the order of Canadian National Steamships; dimensions, 384ft. 6in. by 57ft. by 20ft. 2in. Engines, two sets single-reduction geared turbines; constructed by the builders; launch April 3rd.

DJEBEL-DIRA, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Compagnie de Navigation Mixte; dimensions, 336ft. by 44ft. 9in.; to carry 3500 tons deadweight. Engines, double-reduction geared Parsons turbines; constructed by the builders; trial trip, April 10th.

FILEFJELL, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of A/S. Filefjell; dimensions, 474ft. by 59½ft.; to carry 11,000 tons of oil in bulk. Engines, Wallsend Sulzer type single-acting two-stroke cycle; constructed by Wallsend Slipway and Engineering Company, Ltd.; launch, April 11th.

HAVBOR, motor ship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of A/S. Havbor; dimensions, 474ft. by 59½ft.; to carry 11,000 tons of oil in bulk. Engines, Wallsend Sulzer single-acting two-stroke cycle; constructed by the builders; launch, April 11th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

CAPT. H. G. BELL, M.Sc. (Tech.), A.M.I.E.E., has been appointed by the Central Electricity Board to be Technical Assistant to Mr. Robert Blackmore, Chief Engineer for the North-Western Section of the grid.

BRADLEY AND FOSTER, Ltd., of Darlaston, ask us to announce that they have acquired the West Coast Refinery at Cleator, Cumberland, and are retaining the original management and methods of manufacture of that undertaking.

HOLDEN AND BROOKE, Ltd., of West Gorton, Manchester, ask us to announce that their London office has been moved from No. 315 to Nos. 562/564, Abbey House, Westminster, S.W. 1. The office is still under the management of Mr. W. Richard.

MR. HENRY ASHMAN REED, M. Inst. C.E., M.I. Mech. E., who has held the position of chief engineer of the Manchester Ship Canal Company since 1912, has retired and has been appointed consulting engineer to the company. Mr. Fred Berry Greenwood, M. Inst. C.E., formerly chief assistant engineer, has been appointed to succeed Mr. Reed as chief engineer.

EDGAR ALLEN AND CO., Ltd., of Sheffield, ask us to announce that they have acquired from Ord and Maddison, Ltd., of Victoria Works, Darlington, that portion of the latter's business relating to rotary screens, rolls, stonebreakers, and tarmacadam mixers. In future Messrs. Edgar Allen will undertake the manufacture and sale of those machines and the various fittings in connection with them.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Crown House, Aldwych, London, W.C. 2, has received from the Port of London Authority an order for a six months' supply of "Mazda" electric lamps.

THE HUNSLET ENGINE COMPANY, Ltd., of Leeds, has received an order for eight tank locomotives for the Gold Coast Railways, to the order and inspection of the Crown Agents for the Colonies. These engines will be built to a modified design of one of the firm's standard engines of the eight-wheeled coupled type, and are required for the transport of manganese ore traffic at Takoradi. The cylinders are to be 18in. diameter by 23in. stroke.

INSTITUTE OF METALS.—The twentieth annual May Lecture of the Institute of Metals will be given on Wednesday, May 7th, by Major F. A. Freeth, F.R.S., on "The Influence of Technique on Research." Southampton will be the scene of this year's meeting of the Institute, which is being held, by invitation of the Mayor and Corporation, from September 9th to 12th. At the morning sessions a dozen papers of metallurgical and engineering interest will be presented for discussion. The afternoons will be devoted to visits to works in the neighbourhood of Southampton and also to a visit to Portsmouth Dockyard. There will be a luncheon on board the "Mauretania"—by invitation of the Cunard Company. On September 12th motor trips will take place in the New Forest and round the Isle of Wight. A novel excursion is being arranged for the week-end following the meeting. It takes the form of a trip to France and back in Atlantic liners. The party will cross to Cherbourg on September 13th in the "Mauretania," the return passage being made on September 16th in the "Berengaria." From Cherbourg motor excursions to Mont St. Michel, Dinard and other places of interest will be arranged.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 21/–
(1) Spanish	21/6 to 23/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 10 0	3 10 0
Silicious Iron	3 10 0	3 10 0
No. 3 G.M.B.	3 7 6	3 7 6
No. 4 Foundry	3 6 6	3 6 6
No. 4 Forge	3 6 0	3 6 0
Mottled	3 5 6	3 5 6
White	3 5 6	3 5 6
Midlands—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*); 4 11 6 (*b*); 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 17 6	—
Sheffield—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
Midlands—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (cash)	163 12 6
„ (three months)	165 12 6
Copper (cash)	69 5 0
„ (three months)	67 5 0
Spanish Lead (cash)	18 5 0
„ „ (three months)	18 8 9
Spelter (cash)	18 6 3
„ (three months)	18 18 9
Manchester—	
Copper, Best Selected Ingots	75 15 0
„ Electrolytic	83 0 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	20 5 0
„ Foreign	18 17 6
Spelter	18 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/1 per lb.	
Ferro Tungsten	2/10 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 0 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/6
„ „ Ell	14/6
„ „ Splint	16/6 to 17/6
„ „ Trebles	12/–
„ „ Doubles	11/–
„ „ Singles	10/9
Ayrshire—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	17/–
„ „ Trebles	12/6
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	10/9 to 12/9
Screened Navigation	16/6
Trebles	11/9
Doubles	11/3
Singles	10/9
Lothians—	
(f.o.b. Leith)—Best Steam	12/3 to 12/6
Secondary Steam	12/3
Trebles	11/3
Doubles	11/–
Singles	11/–

ENGLAND.

(8) N.W. Coast—	
Steams	21/6 to 23/–
Household	36/– to 51/–
Coke	22/– to 22/6
Northumberland—	
Best Steams	13/9
Second Steams	13/–
Steam Smalls	10/– to 10/6
Unscreened	13/–
Household	25/– to 37/–
Durham—	
Best Gas	16/–
Second	13/9 to 14/3
Household	25/– to 37/–
Foundry Coke	26/– to 29/–
Sheffield—	Inland.
Best Hand-picked Branch	26/6 to 28/– —
Derbyshire Best Bright House	21/– to 23/– —
Best House Coal	20/6 to 21/6 —
Screened House Coal	18/6 to 20/– —
„ „ Nuts	16/6 to 18/– —
Yorkshire Hards	15/6 to 17/– —
Derbyshire Hards	15/6 to 17/– —
Rough Slacks	9/– to 10/– —
Nutty Slacks	7/6 to 8/6 —
Smalls	3/– to 5/– —
Blast-furnace Coke (inland)	17/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	19/6 to 20/–

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	13/6 to 14/–
Ordinary Smalls	12/9 to 13/3
Washed Nuts	17/– to 21/–
No. 3 Rhondda Large	20/6 to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	32/6 to 37/–
Furnace Coke (Export)	25/– to 27/6
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	27/6 to 28/–
Swansea—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	28/– to 32/–
Red Vein	23/6 to 27/6
Machine-made Cobbles	42/6 to 45/–
Nuts	43/– to 46/–
Beans	25/– to 27/6
Peas	19/6 to 20/–
Breaker Duff	10/– to 10/6
Rubbly Culm	10/9 to 11/6
Steam Coals :	
Large	19/6 to 20/6
Seconds	18/6 to 19/6
Smalls	12/6 to 13/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Machine Tools.

After two years of fairly satisfactory business, machine tool makers have entered upon a period of slack buying which offers few signs, at the moment, of a probable recovery. Until some months ago, British firms supplied large quantities of machines to motor car manufacturers and that constituted about one-half of their French turnover, but the business ceased with the slump in the automobile industry. The situation is now far from reassuring, as there are few other industries in which machines for repetition work are required and British makers are looking more particularly now to electrical engineering and railway works as customers for the heavier classes of machine tools. The Conseil Supérieur des Chemins de Fer has approved the programme which has been prepared by the railway companies to cover their requirements during the next five years, and as that will mean more activity at the locomotive and wagon building shops, as well as at the companies' own works, it is hoped that a renewal of plant will necessitate the purchase of machinery. The situation of British machine tool makers in competition for foreign trade is not unsatisfactory. The British prices are generally below those of the Americans, although there has always been a good market for American machines designed for specialised work, and British productions appeal to customers who want machine tools for a wider range of usefulness. Competition comes principally from Germany, which supplies machines to France at appreciably below the British prices. The Germans have a great advantage in sending enormous quantities of machines for reparations, and, on account of the long terms of credit allowed by the State to buyers of these machines, some big factories have been almost entirely equipped with them. While not desiring to detract from the quality of foreign machines it may, nevertheless, be affirmed that, in some cases at least, the experience of those who have put down reparation material and have had it under frequent repair and adjustment, points to the indisputable fact that while British machine tools may cost more in this country, they are far more economical in the long run.

Tidal Energy.

A communication recently made to the Société des Ingénieurs Civils upon the well-known Dufour system for utilising the energy of tides by means of a combination of two reservoirs and a method of controlled sluices whereby the turbines run continuously and the electrical energy produced can be adjusted to the normal daily loads, was chiefly interesting by reason of the information given concerning progress in this branch of research work. The progress appears to have been very slow. Monsieur Pawlowski, who gave a preliminary address, remarked that, although work was begun upon the experimental Aber W'rach station a few years ago, practically nothing had been done with it for some time past, and he declared that, as the continuous working of the plant depended upon an auxiliary fresh-water reservoir, it could not solve the problem of utilising tidal energy. Several companies are endeavouring to develop tidal power schemes, but no practical work of any kind has yet been accomplished. Nevertheless, Monsieur Pawlowski believes that tidal power schemes on the Dufour principle can be made both commercially and financially successful, on condition that they are linked up with thermal plants at the collieries and hydro-electric installations with the idea of ensuring an uninterrupted supply all over the country. The idea of utilising tidal energy is particularly interesting to this country, because France cannot produce all the fuel she needs and in few places are there such amplitudes of tides as those from the Somme to the coast of Brittany where they range from 4 m. to 11 m. and more. The tidal resources have been carefully investigated, and it is declared that along the coast about twenty stations can be installed, capable of producing something like 2,500,000 horse-power at a cost of electric current a little more than that of heat plants, but less, it is affirmed, than the price of current delivered by the hydro-electric installations.

Shipbuilding.

Entrusted with the task of investigating the reasons for the great difference between the prices of French and foreign shipyards, the Conseil National Economique has just issued a report, in which it states that the difference is due to insufficient orders and their irregularity, to the distance of shipyards from the sources of raw material supply and to the heavy Customs tariffs and fiscal charges. The remedy suggested is that the State should provide shipbuilders with financial assistance during a limited period, but that such aid must be dependent upon the carrying out of a programme of concentration, rationalisation and standardisation. It is suggested that a special commission, composed of shipbuilders, engineers, employees and workmen, should be appointed to determine what improvements are necessary to ensure economy in ship construction. It is also stated that collective agreements between shipbuilders and the men are desirable.

Scrap Metal.

The export of scrap metal is strictly limited and permits have to be obtained for consigning it to other countries, the amounts being fixed by arrangements with the Governments concerned. The largest consignments were formerly made to Italy, which has to rely upon supplies of foreign scrap, and during the period of industrial activity a considerable business was done in scrap metal. For some months past there has been an accumulation of scrap, and the market has been overshadowed by huge stocks in Germany which have depreciated prices. The situation of dealers is now precarious.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

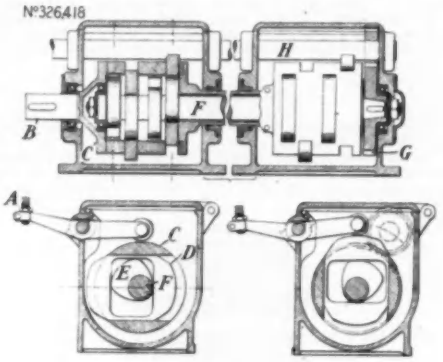
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM ENGINES.

326,418. June 1st, 1929.—Valve Gear, E. Renaud, 67, Place Saint-Paul, Rouen (Seine-Inferieure), France.

This valve gear is said to be specially suitable for steam locomotives, and is of the tappet operated type. One of the tappets is shown at A. The shaft B is driven at half the speed of the main crank shaft and carries a drum C. This drum is slotted transversely for the reception of the sliders D. These sliders have a

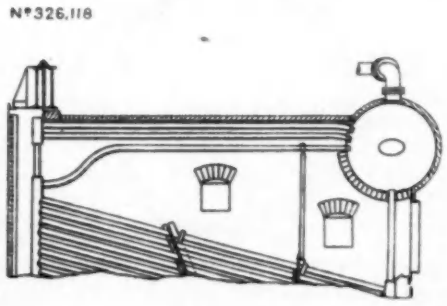


rectangular opening in the middle, in which there operate the cams E. The cams are on a shaft F, which does not rotate with the shaft B, but can be angularly displaced by the gear G and shaft H. The cams have the effect of making the sliders protrude from the drum C and operate the rocking levers of the tappets. The angular position of the cams determines the period of opening and closing of the valves. Very similar gear is used for the exhaust valves.—*March 13th*, 1930.

STEAM GENERATORS.

326,118. July 11th, 1921. Water-tube Boilers, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.* 4.

According to this invention, some of the circulators for steam and water are connected directly from the steam and water drum to the uptake headers as heretofore, while others are connected to boxes which are in turn connected to the uptake headers. The invention, it is claimed, is especially useful in positions where

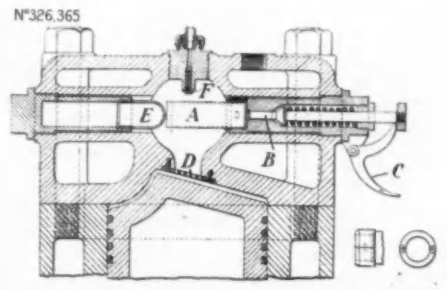


it is desirable to increase the effective area of the circulating tubes between the uptake headers and the steam and water drum in a boiler of this type without increasing the height of the boiler, or where the headers would be too long for shipment or other purpose, or where it is desired to make the headers shorter, using nipples to connect these headers to other headers and circulators to connect the other headers to the steam and water drum, thereby decreasing the flow resistance.—*March 6th*, 1930.

INTERNAL COMBUSTION ENGINES.

326,365. March 21st, 1929.—Starting Diesel or Semi-Diesel Engines, D. D. Lago, Avenida Alberdi, 593, Rosario, Argentina.

The inventor proposes to start an oil engine by means of an

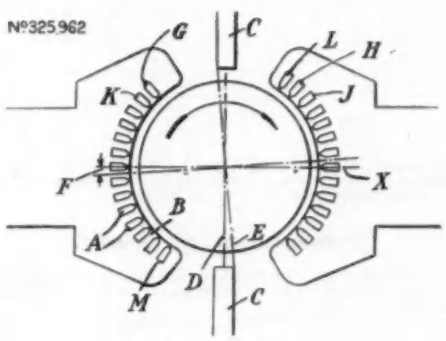


explosive cartridge A, which is fired by means of the pin B and trigger C. The type of explosive is not mentioned, but it is said to be impregnated with inflammable material. At the opening of the combustion chamber there is a grid D, which retains the particles of inflammable material and ensures ignition for several strokes of the engine. The whole of the cartridge is ultimately consumed. E is a hot point to maintain combustion when the engine is running and F is the fuel valve.—*March 13th*, 1930.

DYNAMOS AND MOTORS.

325,962. January 28th, 1929.—Dynamo-electric Machines, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2, and James Cooper Wilson, of Siemens Works, Stafford.

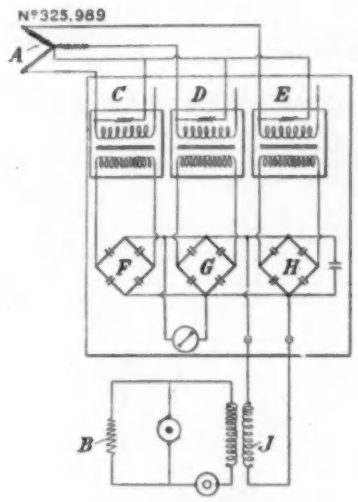
This invention relates to dynamo-electric machines having compensating windings arranged in slots A in the pole faces B. Direct-current generators of this type provided with commutating poles C show a tendency to give a rising voltage characteristic with increasing load, even when the field windings are shunt or separately excited without the addition of cumulative series winding. If such machines are used to drive a motor on the Ward-Leonard system, they tend to force a current through the motor even if their fields are unexcited, unless expensive negative series windings are employed. Difficulties are also encountered when such machines are paralleled. In machines of this type, the magnetic axis of the compensating winding is coincident with that—D—of the commutating poles and at right angles to the main pole axis X, thus having no direct influence on the main field strength. According to the



invention, the slots A for the compensating winding are displaced slightly in a circumferential direction. The effect of this is to tilt the magnetic axis E of the compensating winding, so as to create in a generator a demagnetising component for the main poles, and in a motor a magnetising component. The tilt is opposite to the direction of rotation in a generator and in a motor where it is desired to give increased stability or avoid rising speed characteristics. If the displacement amounts to half a slot pitch F, it will be seen that pairs of slots G, H, K, J, &c., still remain in opposite pole faces, producing a magnetic axis D at right angles to the main pole axis, and therefore with no demagnetising effect, but that the net result is one slot in each pole face left over in the direction of tilt, these slots forming a pair L M, which have an axis very appreciably tilted, and therefore, almost wholly effective in demagnetising the poles. Such a demagnetising compensating winding can be used in conjunction with a forward series winding, when a level or rising characteristic is desired, the series windings of a number of machines being paralleled as usual.—*March 6th*, 1930.

325,989. February 12th, 1929.—Alternating-current Dynamos, Bernard Joseph Shillito, of Henry Wallwork and Co. (1920), Ltd., Union Bridge Ironworks, Rogerstreet, Manchester.

This invention relates to alternating-current dynamos, and has for its object to maintain a more constant terminal voltage than hitherto at different current outputs, or, if desired, to produce an increase of voltage beyond the increase hitherto



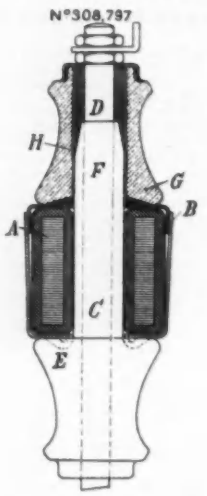
obtainable at the full output of the alternating-current dynamo. In the diagram A is the main alternator winding and B the field winding. Transformers with shunt and series windings are shown at C D E. The secondaries of these transformers feed rectifier groups F G H connected to an additional field winding J on the poles of the exciter. As the load increases the three transformers C, D, and E and rectifiers F G H cause the winding J to provide extra excitation which compensates for the fall in voltage.—*March 6th*, 1930.

TRANSFORMERS AND CONVERTERS.

308,797. March 20th, 1929.—Insulators for the Primary Conductor of a Current Transformer, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

In the drawing A is the iron body consisting of plate rings of the ring current transformer, wound with the secondary winding B. The insulating body C containing the rod-shaped primary conductor D is inserted in the transformer aperture. The strength of the walls and the outer diameter of the inserted part are only such as are required by the resistance to disruption in the transformer aperture. One end of the insulating body

is, on the contrary, thickened in the form of a collar at E corresponding to the usual insulator shape. The insulating body is inserted in the transformer aperture until it abuts on this collar. Over the thinner end F of the insulator the

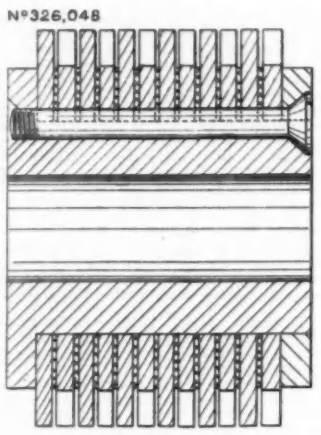


roll-shaped solid insulating body G is forced. The joint H between the two bodies is insulated, for example, by pouring in an insulating mass.—*March 6th*, 1930.

TRANSMISSION OF POWER.

326,048. April 2nd, 1929.—Laminated Gears, A. Keighley, Sedgley-road, Sheffield, and Thos. W. Ward, Ltd., Albion Works, Sheffield.

In order to silence staggered tooth laminated gear wheels,

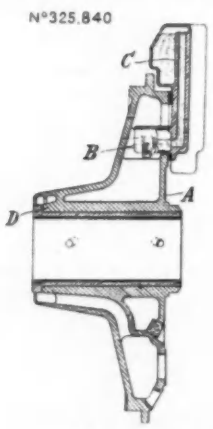


the inventors build up the wheel of alternate layers of steel toothed rings and such a material as compressed cardboard, which has a period of vibration different from that of the steel.—*March 6th*, 1930.

TRAMWAYS AND RAILWAYS.

325,840. November 29th, 1928.—Axle Lubricating Devices, the British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2, and W. Emery, 40, Lancaster-road, Rugby.

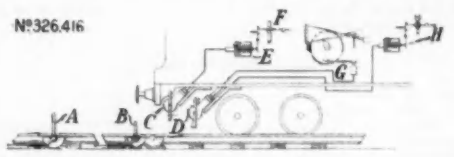
This invention relates to lubrication devices and more particularly to devices for oiling the axles or bearings of electric motors used in railway or tramway traction. As it is not convenient to lubricate these bearings at frequent intervals, it is necessary to provide a reservoir capable of holding a considerable



amount of lubricant which is fed to the bearing as required. The object of this invention is to provide a lubricating device which can be fitted to existing frameheads without any structural alteration. In the construction illustrated in the drawing, the motor framehead A is provided with an aperture into which fits a projecting portion B of the lubricating device C. The bearing D is supported in the framehead A and the constant level chamber from which the lubricant is fed to the bearing is partially disposed within the projecting portion of the casing so as to be directly above the bearing. It will be understood that the aperture into which the portion B of the lubricating device fits is one which is provided in the framehead in any case, so that no aperture has to be specially bored to receive the lubricator.—*February 28th*, 1930.

326,416. May 28th, 1929.—Track Control of Steam Locomotives, E. Rodolausse, Saint Antonin (Tarn-et-Garonne), France.

This specification covers a system of controlling locomotives by pneumatic means, actuated by tappets on the permanent way, as shown at A and B. On the engine there are three air compressors, two of which are shown at C and D—the third is

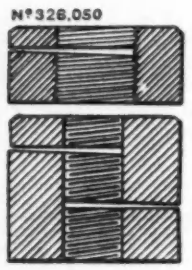


behind D. The action is as follows:—As a first precaution against overrunning signals, the tappet A operates the compressor C and, through the pneumatic cylinder E, the brake valve F. The second tappet B works another compressor D for the operation through the cylinder G of a "warning and control apparatus for stopping or slowing down." Finally, the third tappet gives an "all clear" signal at H.—*March 13th*, 1930.

MISCELLANEOUS.

326,050. April 2nd, 1929.—Lock Nuts, S. E. Ellis, Greta, Victoria, Australia.

The inventor proposes to make a lock nut by cutting one or more slits through more than half its diameter, after it has been



tapped, and then squeezing the parts together. The nut is tempered and will, he says, remain locked even if it is not screwed down hard on to the job.—*March 6th*, 1930.

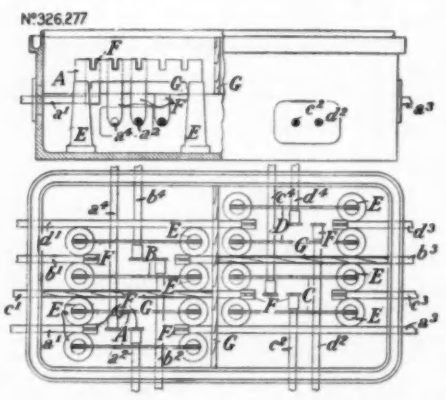
326,121. July 19th, 1929.—Casting Rain Water Gutters, the Anderston Foundry Company, Ltd., and T. P. Cargill, Port Clarence, Middlesbrough.

The inventors propose to cast rain water gutters in pairs,

face to face, as shown, with narrow necked connecting pieces, which can easily be broken to separate the two halves.—*March 6th*, 1930.

326,277. December 31st, 1928.—Electrical Distribution Network Disconnecting-box, Hugh Marshall Price, "Arundel," Streetsbrook-road, Shirley, Birmingham.

The object of this invention is to provide improved means whereby the required connections in a distribution system can be effected more conveniently than is possible with the apparatus ordinarily used. The invention comprises, broadly, the employ-



ment in distribution disconnection boxes of duplicate independent bus-bars. The box is fitted with pairs of bus-bars by A B C D. Each bar is carried on insulating pillars E and may be notched to facilitate the attachment of the cables by means of screws, bolts, or other fastenings. To the inner end of each cable a lug F is attached for connection with a bus-bar. Another feature is that the interior of the box is subdivided into unequal compartments by transverse wood or other insulating partitions G. The two pairs of bars in the left-hand group are displaced relatively to the two pairs in the right-hand group, so that whilst three bars in each side are opposite three bars in the opposite side, one bar in each side is without a counterpart. It is usual to identify the cables by insulations of different colours, such as red, blue, green and white. The prepared cable ends are brought in through the opposite sides and ends of the box and are grouped as follows:—Indicating all cables of one colour by a^1, a^2, a^3, a^4, those of another colour by b^1, b^2, b^3, b^4, and those of other colours by c^1, c^2, c^3, c^4, and d^1, d^2, d^3, d^4, all the ends of the cables of one colour, say, a^1, a^2, a^3, a^4, are brought in so that they lie between the pairs of bars A. Likewise the ends of the cables b^1, b^2, b^3, b^4 are arranged to lie between the bars B. The cable ends marked c^1, c^2, c^3, c^4 lie between the bars C, and those marked d^1, d^2, d^3, d^4 lie between the bars D. Any of the first group can be attached to either of the bars A, and likewise any of the other groups can be attached to either of their corresponding bars. It follows that the cable ends in each group can all be connected together, either by joining the bars or by joining all the cables to the same bar. Or they may be grouped together in any desired manner. By means of this invention it is possible to simplify the making of connections on distributing systems, and the one box may be used for a single system, in which case the two bars in each pair may be coupled together, or it may be used for connecting the cables of two or more independent systems, in which case the two bars in each pair would not be coupled together.—*March 13th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

FRIDAY, APRIL 25TH.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. "The Economical Production and Distribution of Steam in Large Factories," by Mr. F. Carnegie. 6 p.m.

WEDNESDAY, APRIL 30TH.

Machine Tool Trades Association.—King's Hall, Holborn Restaurant, High Holborn, W.C. 1. Annual dinner. 6.45 p.m. for 7.15 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, E.C. 4. "Ancient Civilisations," by Major E. A. Marples. 5.30 p.m.

THURSDAY, MAY 1ST.

Institution of Civil Engineers: Birmingham and District Association.—Prince's Chambers, 6, Corporation-street, Birmingham. Annual general meeting.

Iron and Steel Institute.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 p.m. for 7.30 p.m.

THURSDAY AND FRIDAY, MAY 1ST AND 2ND.

Iron and Steel Institute.—At the Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

FRIDAY, MAY 2ND.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Discussion on "Empire Free Trade and the Engineer," to be introduced by Major A. W. Farrer. 7 p.m.

WEDNESDAY, MAY 7TH.

Institute of Metals.—At the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Twentieth Annual May Lecture, "The Influence of Technique on Research," by Major F. A. Freeth. 8 p.m.

WEDNESDAY, MAY 14TH.

Institution of Mechanical Engineers: Yorkshire Branch.—Whole-day visit to Hope Cement Works.

"The Charles R. E. Bell Fund" Scholarships.—The successful candidate for the "Charles R. E. Bell Fund" Junior Scholarship of £60, offered by the London Chamber of Commerce on the results of the Winter (February) Examination, 1930, was Frank V. Lay, presented from the Tollington Park L.C.C. Central School, Marriott-road, London, N. 4. The London Chamber of Commerce offers another "Charles R. E. Bell Fund" Scholarship of £60 on the results of the Summer (July) Examination, and two "Charles R. E. Bell Fund" Senior Travelling Scholarships of £150 each on the results of the Spring Examinations, 1930.

Metallurgists' Trip to America.—Plans for an American meeting of metallurgists, to be held by the Institute of Metals in the United States and Canada two years hence, are now taking definite shape. The Reception Committee of the Institute's hosts in U.S.A.—the American Institute of Mining and Metallurgical Engineers—has prepared such an attractive draft programme that nearly 100 British members have already booked for the trip. It is expected that the party from England will be joined by a large proportion of the Institute's 300 American members, as well as by many members from continental countries. The visit will include official meetings of the Institute in New York and joint meetings with allied societies in Detroit and Toronto. Other places to be visited include Pittsburgh, Cleveland, Chicago, Niagara and Montreal. In all of these, works will be thrown open for the inspection of the visitors. The party is expected to leave Southampton on September 3rd, 1932. The meeting in New York will begin on September 11th, and the return journey will start from Montreal on September 30th.

Faraday House Entrance Scholarships.—As a result of the entrance scholarship examination held at Faraday House Electrical Engineering College on April 8th, 9th and 10th, the following awards have been made by the Governors of the College:—John A. Evans (County School, Carnarvon), "Faraday" Scholarship of 80 guineas a year, tenable for two years in College and one year in one of the works affiliated with the College; Nicholas Worobjeff (University College School), "Maxwell" Scholarship of 60 guineas a year, tenable for two years in College and one year in works; David A. Lamb (Downside School), an Exhibition of 40 guineas a year, tenable for two years in College and one year in works; Charles W. Sex (the Tiffin Boys' School, Kingston-on-Thames), an Exhibition of 30 guineas a year, tenable for two years in College and one year in works; William M. Bennett (Epsom College), an Exhibition of 20 guineas a year, tenable for two years in College and one year in works; Eric M. Davey (Towyn County School, Merioneth), Entrance Prize of 10 guineas; and Kenneth A. Watson (Dollar Academy), Entrance Prize of 10 guineas.